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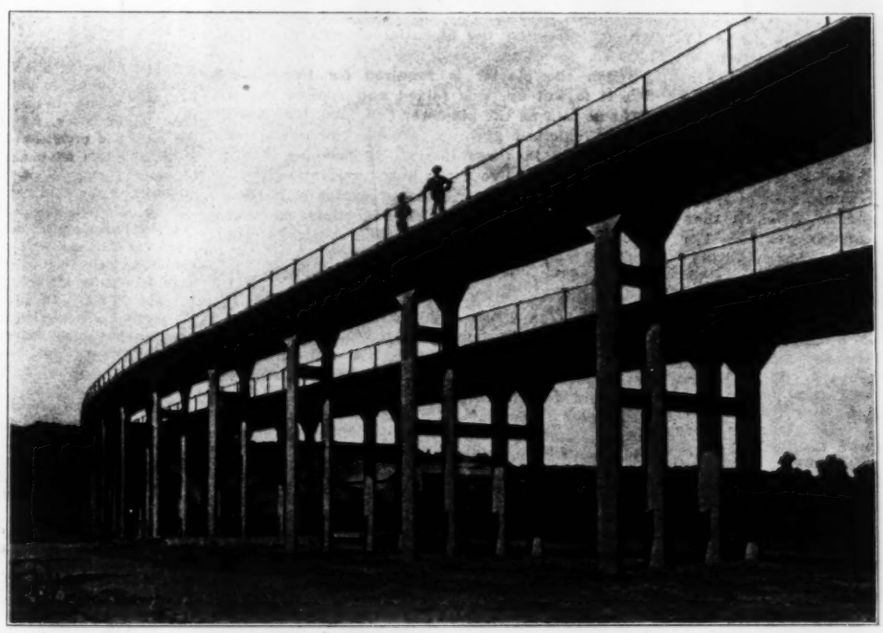
REINFORCED CONCRETE TRESTLEWORK VIADUCT FOR A SPANISH MINERAL RAILWAY.

Two trestlework viaducts of reinforced concrete, with an aggregate length of 207 m. (679 ft.) and a height of between 30 and 40 ft. have been constructed on the railway line from the Cala iron mines to the Guadalquiver River, near Seville, Spain. The purpose of the railway is to take ore from the mines some 97 kilometers (60 miles) to ore vessels navigating the river, and the viaducts with an intervening embankment carry the line across the broad flood channel of the stream to a loading pier on the edge of deep water in the normal channel. From this point to the Atlantic Ocean, 95 kilometers (59 miles), and thence abroad, the ore is taken in vessels.

Of the two viaducts the longer is inshore and has a total length of 117 m. (371 ft.); a view of this structure is given by the accompanying picture. From the end of this viaduct an embankment 86.5 m. (284 ft.) extends to the inshore end of the second viaduct, shown in side elevation by Fig. 1, and which terminates in the loading pier. The scheme of handling cars to and from the loading platform involves two tracks; a locomotive pushing a train of ore cars ahead advances to the loading pier on one track, where the cars are tipped and discharged one at a time and sent back on the second track by gravity to a point back of the inshore viaduct, where they are again assembled into trains.



REINFORCED CONCRETE TRESTLEWORK VIADUCT FOR A SPANISH MINERAL RAILWAY.

The two viaducts are substantially alike in construction; each consists of two parallel single-track structure, as indicated by Fig. 1, and more clearly by the cross-section, Fig. 2, of the longer viaduct. The bents, which are spaced 9 m. (29.52 ft.) apart on centers, are each composed of four posts, 0.67 × 0.23 m., in section. Each longitudinal line of posts carries a girder 1.2 m. deep and 0.23 m. thick (3.94 ft. × 0.75 ft.), and the two girders for each track carry a slab, whose outer edges bracket over the girders to form sidewalks. The reinforcement of the girders is shown by Fig. 3. The bracing connecting the bent posts transversely is shown with its reinforcement by Figs. 2 and 3. Fig. 2 also shows the footing for the bent posts; this consists of a slab 20 cm. (5 ins.) thick, 1.75 m. (5.74 ft.) wide and 7 m. (23 ft.) long, stiffened by a rib or girder between posts. A footing of plain concrete 30 cm. (7.62 ins.) thick supports the reinforced slab. With the maximum possible loading this footing brings a pressure of 2,362 lbs. per sq. ft. on the soil.

The actual train loads for which the viaducts are designed are made up as follows: A locomotive of 48 metric tons (36 tons on coupled axles 2.85 m. apart and 12 tons on a bogie with axles 1.6 m. apart) and 20 cars carrying 20 tons each on axles 1.6 m. apart.

The loading pier is shown in sectional plan by Fig. 4, and in side elevation by Fig. 1. The main supporting members are 14 columns, which form continuations of 14 reinforced concrete piles constructed, as shown by Fig. 5. These columns are braced together by two platforms, one at track level and the other at ground level, and by horizontal struts at two intermediate levels as shown. The struts are 32 × 32 cm. (12.6 × 12.6 ins.), and the girders carrying the platform slabs are of the same dimensions. The diagonal bracing is used only in the two lines of columns between which the ore chute is placed; the diagonals are of the same cross-section as the struts.

The completed viaduct was subjected to elaborate tests, under which it exhibited very little deflection or vibration. The preceding description has been compiled from an article in "Le Genie Civil" of Dec. 23, 1905, by Mr. Juan-Manuel de Zafra, Under Director of Works, Port of Seville, Spain.

A NEW MAGNESIUM OXY-CHLORIDE CEMENTING MATERIAL.

By Thos. W. Cappon.*

Many years ago the French chemist, Sorel, pointed out to engineers and architects the great cementing powers of magnesium oxy-chloride, and "Sorel Stone" as it is called, has to-day many applications in the arts. Its usefulness, however, has been much restricted owing to the comparative scarcity and high price of the raw material, much of which is imported from Greece and to the fact that the cement is slightly attacked by water, a serious objection in the manufacture of artificial stone, for which it was deemed to be especially suited.

It is not necessary, however, to go so far for magnesia; abundant supplies of it exist in this country, in the "lean" or dolomitic limes, in which the magnesia has been hitherto considered a detriment rather than an advantage, and can be had at less than one-third of the cost of the foreign product. To extract it from the mixed oxides of lime and magnesia in which it exists to the extent of 40%, is a tedious and expensive process; though it is done in some western states. To transform it to oxy-chloride directly, and so utilize its cementing power, is impossible, because of the superior affinity of the lime with which it is associated, and the power of the latter in breaking up magnesium compounds. The seemingly paradoxical result is obtained, nevertheless, by the intervention of another compound, the carbonic acid of the air, which in conjunction with calcium chloride reverses the normal reaction by transforming the lime into basic carbonate, and the magnesia into oxy-chloride of magnesia.

As this later modification of the Sorel process substitutes for magnesium chloride, a cheaper material, calcium chloride, and carbonates the latter, the "cast stone" of the process is better fitted to resist the solvent action of water; owing to the fact that oxy-chloride so produced is interlaced with insoluble carbonate of lime.

USE IN WALL PLASTER.—It is generally known that lime can be stiffened with Portland cement to form good hard plaster; but it is not

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necessary to tell those who have experience with it that it will not give the "quick setting" property, which is so convenient a feature of the modern "hard plaster;" nor can it be used where light colored work is desired; but hydrated dolomite lime, which contains magnesia, may be treated to utilize the cementing powers of this constituent, and when so treated (with a cheap chloride like calcium chloride) it will be found to compare favorably with "hard plaster" made from gypsum. The following tests show the relative strength of lime plaster, treated and untreated: Three briquettes made of 2 parts by weight of sand to 1 of lime (high calcium, or pure) broken after 1 month, showed per sq. in. section a tensile strength of 27 lbs., 22 lbs. and 32 lbs. for three samples.

Whereas in the case of dolomite lime, the average strength does not reach 27 lbs. per sq. in., the briquettes sometimes breaking while being placed in the machine; after treatment, this dolomite lime shows greater tensile strength than the strongest pure limes, not so treated. For example: Sample B after 18 days showed 78 lbs.; sample H after 33 days showed 145 lbs., and sample C after 30 days showed 135 lbs. Samples B and H consisted of 6 parts by weight of sand to 1 of hydrated dolomite lime (treated), and sample C contained 4 parts of sand and 1 part of marble dust to 1 part of hydrated dolomite lime (treated).

Varying amounts of chloride may be used, from 5 to 15%, by the weight of the lime taken; but for most purposes, such as artificial marble, "finish" and "hard wall plaster" 5% will be found sufficient. The usual amount of hair, asbestos fiber, pulp or clay is added, or omitted altogether, according to the nature of the work, without affecting the essential character of the process.

When the plaster is required for immediate use, it is wet up, well mixed and applied to the walls as stiff as the plasterer can work it. When 10% of calcined gypsum is used, the initial set takes place in three hours. It becomes fairly hard in four or five days; but it resembles Portland cement in that it becomes gradually harder, and attains great hardness in three or four weeks. Where a quick set is not required, the gypsum may be dispensed with.

FORMULA FOR EXTERIOR WORK.—In cases where a strong, light colored plaster is needed, as for covering the exterior of buildings, the following may be used, the proportions being by weight: 100 parts light colored sea sand; 50 parts marble flour; 38 parts hydrated dolomite lime, and 2 parts calcium chloride.

A good substitute for marble, or "artificial marble," may be made by substituting finely powdered marble dust, or "flour," for sand in the above formula, and mixing it with hydrated lime treated with chloride as above. The lime used should be bolted, or air separated, so as to form a fine powder. Absorption tests of plaster made on the above formula showed from 6.8% to 7%, by weight, of water absorbed. By substituting marble dust, the absorption was increased to 12.5%.

THE PROCESS IN ACTUAL USE.—This process has been applied on a large scale in the cold storage chambers of a large brewery in New York City. The conditions in this case were about as severe as lime plaster could be subjected to; for the fermenting rooms of such buildings, being kept just above the freezing point of water, are liable to condense moisture. A cement mainly composed of calcined magnesia imported at a cost of $30 per ton, had been previously used for this purpose, because of its hardness and resistance to moisture. The hardened lime plaster, however, fully answered both requirements, became very hard, and is in perfect condition.

Only in those rooms where the amount of condensation precluded all chance of drying, was the expensive "magnesian" cement employed. The plasterers preferred the lime cement for its easy spreading qualities, as they were able to cover double the surface with it in a given time, furthermore it was found not nearly crack on drying out as the pure ma ment.

The writer has obtained a patent cess described.

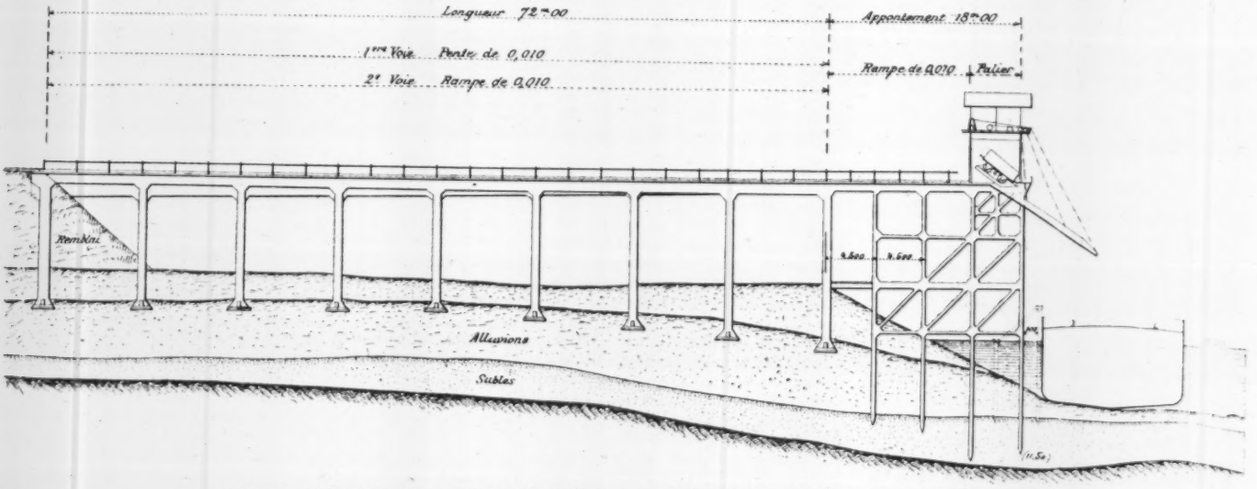


FIG. 1. VIADUCT AND ORE-LOADING PIER OF REINFORCED CONCRETE CONSTRUCTION.

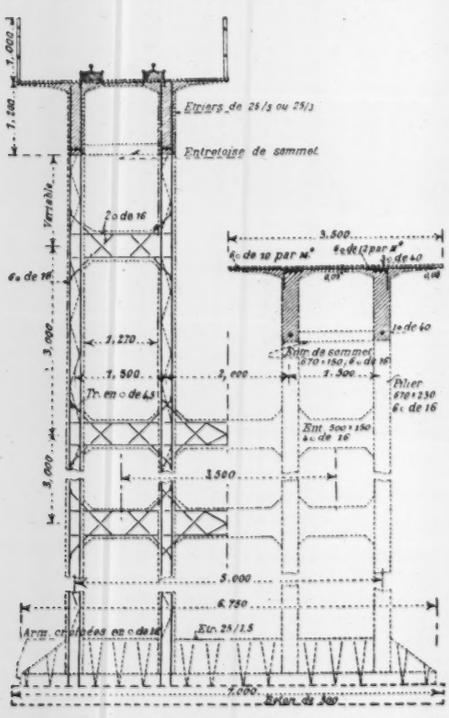


Fig. 2. Transverse Section of Reinforced Concrete Trestlework Viaduct.

TENDENCIES IN THE FOUNDRY INDU RY.*

By Dr. R. Moldenke,†, M. Am. So E

Perhaps the very first thing which strikes foundryman who is visiting our plants is th laid upon system and organization in our ern establishments. Where the European founder, with his more varied work of smaller aggregate tonnage, casts his pieces one by one, and finishes each with the assembling following directly, we, with an eye to the fine economies, prefer to put through an order of anywhere from a dozen to thousands of pieces of a kind, finishing them up for stock, and stealing the parts required for the sales and promises. As the stock in warehouse gets below a certain minimum, another shop order goes in to fill up the gap. As a consequence the work is always produced at the cheapest rates possible.

If we take into consideration that specialty work means the production of the same casting in very large quantities, we can see why machine molding in its various phases is beginning to play such an important role. I have personally known single orders of 100,000 castings of some 30 lbs. each given with simply a blue print of the casting attached to the document. Many times the quantity has been 30,000 to 60,000, which meant that economical work could be done here if anywhere. Actually the figures at which these castings were carried out would be astonishing.

Apart from the use of molding machines to turn out these classes of castings cheaply, there is a noticeable tendency to economize shop room, and hence molds are piled as high as they can be conveniently poured. It may be objected that this method oftentimes produces more sprues per pound of casting than the old way, and that if trouble comes, a stack of molds will be ruined instead of only a single one. Yet this system has been found to pay wherever tried, and the getting of more tonnage for a given floor space is bound to spread. The idea, however, should be followed out to its logical end wherever work is made in sufficient quantity. This would seem to be the stacking up of the molds in fairly deep foundry pits, the iron being brought in large ladles by traveling crane, and poured from the bottom of the ladle. Suitable variations in the method can natural-

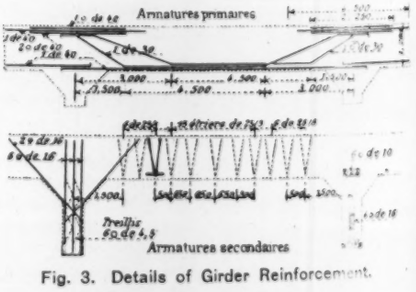


Fig. 3. Details of Girder Reinforcement.

*Extracts from a paper in the "Transactions of the American Foundrymen's Association."

†Consulting Engineer, Watchung, N. J.

ly be de[illegible] for given cases but the idea remains the same; t[illegible] the greatest tonnage for a given floor space, in order [illegible]ave investment and cost of output.

Greate[illegible]ttention will ultimately be given the prepa-ration o[illegible]e molding sand. Our European brethren are far ahe[illegible]of us in this respect, every foundry of im-portanc[illegible]rinding its sand to a given standard, then passing [illegible]ough mixers which incidentally fill the per-fectly u[illegible]rm material with maximum of air, thus cush-ioning t[illegible] sand and keeping it as open as it may be. When a highly refractory, molding sand is used, this

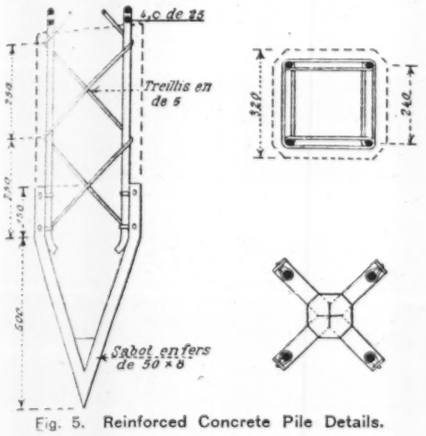


Fig. 5. Reinforced Concrete Pile Details.

treatment assists in turning out the smoothest kind of work. As our consumers are constantly harping on bet-ter looking work, this point might be considered more carefully by American foundrymen. Many sands are ex-ceedingly uniform in their natural state, as for instance the well-known "Albany," the result being highly fin-ished castings, where the best molding methods are em-ployed. On the other hand, who does not recognize a "Pittsburg" casting, that is one made in the sand dug in the environments of the smoky city. Judicious sand treatment would go a great ways to remedy the diffi-culty even there, did the good people make the class of work current in the eastern states. What great dif-ferences may exist in molding sand in the same heap may be seen in an exaggerated way where sand con-veyors are in use. Here, unless special precautions are taken, the loamy particles in the sand may get to-gether, leaving the silicious portions without a binder. The result is that copes drop out, scabs are formed, etc. No wonder that in the ordinary tempering of sand an art is involved which must be acquired before a man can rate himself proficient in this branch of the work. Hence the tendency to get away from imperfections in the make-up of the molding sand heaps, by mechanical grinding and mixing. This tendency has not struck our country very hard yet.

In going through many a foundry where very large loam molds are made for stock work, one cannot help re-gretting the tearing down of much of the mold which might be left standing if the subject of "permanent molds" had been studied more carefully by the foundry foreman. The tendency to-day is to economize in every way possible, and very often here is a chance to begin.

We owe much to our high class custom pattern shops

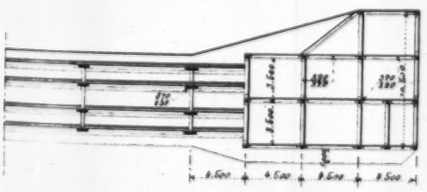


Fig. 4. Sectional Plan of Ore-Loading Pier.

for the progress they have forced upon the pattern end of our industry. It is not so long ago that metal pat-terns were unheard of in many foundries. It seemed like a waste of good money to put more time and effort on a pattern than was required by the ordinary article we all have piled on our pattern shelves. However, this tendency is growing steadily, and many a shop to-day can boast of a set of metal cutting machines which re-mind one of a first-class toolroom.

Turning now to the melting and the closely allied laboratory, we see that the strongest marked tendency of the day in the industry is the production of higher grade castings by the addition of steel scrap, or in other words the reduction of the total carbon in cast iron, mak-ing the crystalline structure more closely adherent, and hence the whole casting stronger. Here the skill of the melter is joined with that of the chemist, so that value is received from the higher priced stock charged into the cupola. The cupola process is being studied more care-fully and experts in that line can produce results close to those of the air furnace, or open hearth. Considering that this is accomplished with fuel and metal in contact, and by a notoriously unsatisfactory melting method, which the cupola process undoubtedly is from the stand-point of the treatment the metal gets in it, the foundry industry is to be congratulated upon its ability to retain a strong hold on the making of castings, in the face of the hard knocks it is getting from the steel casting es-tablishments.

This tendency toward better grades of metal is but in its infancy. The cupola, which is a cheap melter, will undoubtedly be improved with the view of getting better results from the steel scrap additions. The metal will be safeguarded more from burning, and the additions of the scrap will be systematized more, so that a given quantity will produce given results more regularly than is now the case.

The tendency above mentioned has somewhat retarded the introduction of air furnaces in general foundry prac-tice. However, taking into consideration the demand for better irons, better coke, better melting methods, the specialist founder will soon tire of buying high class ma-terial, and spoiling it, or taking big chances in that direction. He will naturally revert to the air furnace as better able to give high class results from high class material, and the consumer will be glad to pay the dif-ference.

Whereas once the melting point of the various cast irons formed the one absorbing topic for articles and dis-cussion, at present it is the elimination of sulphur in the cupola.

With more light on this question, it is but a step to work on others and finally we may get down to a closer study of the burning effects manifested in cupola and air furnace practice, which I hold, are the most im-portant by far of all the phenomena of the foundry melt-ing processes, granted that the chemical composition is otherwise correct.

This leads us to the use of the ferro-alloys in the foundry to correct the evils we know, and others we have a vague apprehension of. To-day the use of ferro-manganese and of aluminum is quite extended, and is really a help in many instances. With the poor pig iron and especially the very poor coke the smaller founder is forced to put up with, the use of either of the above mentioned correctives is to be recommended. Unfor-tunately ferro-manganese is hardly powerful enough to do much good in the foundry, unless the mixture has a goodly proportion of steel in it. When this is the case it means a higher melting point, and with higher tem-peratures than ordinary cast iron is apt to be poured at, much of the oxidation is removed, and we avoid the pin-holes, other weakening and unsightly effects which seem to be somewhat the rule at the present day. The real foundry alloy, however, is still to be discovered and made commercially, and the day cannot come too soon for this desideratum to be realized.

Finally we come to the general problems of the foundry, in which there are also marked tendencies for a change. This will probably affect only the very large in-dustries for the present and next generation, but what may come after is hard to say. Foremost stands the rapidly increasing use of direct metal. This is more marked across the water, but is bound to come here also. The big segments for the tunnel shields and lin-ings should never have been made of remelted metal. However, this does not mean that it was advisable from the first to jump into a new method for such vast con-tracts. Here again we strike the importance of the use of steel scrap in gray iron castings, in order to reduce the total carbon. I would not advocate the use of direct metal just as it is, but to have the stream of metal from the blast furnace go into large heated mixers, which means greater, in fact more easily attained uniformity than is ever possible with the cupola. Now into this mixer there should be charged successively quantities of steel scrap which has been heated up to almost melting. This accomplishes a two-fold purpose. First it gives a reduction of total carbon without lowering the tempera-ture of the metal in the mixer too seriously not to be cor-rected at once by the heating method used as well as the comparatively large quantity of metal that should be in the mixer all the time. Now the first result is the making of a high grade cast iron. This iron should be good enough for all the purposes the process could be used for, such as the making of pipe, tunnel segments, ingot molds, etc.

The second effect of the addition of the preheated steel scrap is that the problem of "kish" is done away with. This is the bugbear of the direct metal foundry, and in fact has retarded the introduction of direct metal for important work so much that at one time it was thought out of question to think of ever going back to this centuries old way of making castings.

What then will be the result of this tendency? It means that blast furnaces will be located wherever the raw materials not only are favorable, but where there is a good shipping point for pipe, possibly car wheels, and not impossibly, malleable castings for car work. The furnace proposition will then become one of allied industries to give an outlet for the pig iron made which will fit these uses, and all the pig iron not of composition to go into the various mixers will be put upon the market.

While this seems visionary, it is nevertheless a fact that one very large combination is about to break ground for just such an establishment, and we may hear from direct metal pipe very soon. With our American enter-prise, one hesitates to say just where those changes in method of production as well as administration will end, and it is even within the range of possibilities to find stoves made at a blast furnace once the molding machine has conquered the field that is before it in that line.

Being in fairly close touch with the scientific and ad-ministrative end of the foundry industry, I can say that most of these tendencies have been put up right against me in one way or another during the last few years, and I can safely say that with the need of betterments at hand, and this need no longer capable of being attended to by the old-fashioned yet highly respected men on the foundry floor; it remains for the men at the very top of our great industrial establishments to solve the fine points in producing enormous quantities of high grade castings, and to make them cheap. These men are to be found in our foundrymen's associations, in our great en-gineering societies, and wherever the active individuals of our industry get together to discuss questions of practice.

THE GASOLINE MOTOR CARS of the Union Pacific Ry. were described and illustrated in our issue of Dec. 21, 1905, and a new car differing somewhat in details has recently been completed. The new car is of steel con-struction throughout, with steel sheathing, and has a central vestibule with the steps enclosed within doors flush with the side of the car, the side sills being de-pressed at the middle to clear the steps. The front truck carries the engine and has a pair of 42-in. driving wheels and 33-in. trailing wheels, with a wheelbase of 9 ft. 2 ins.; the rear truck has 33 in. wheels and a wheelbase of 7 ft. The car is 57 ft. long, 12 ft. 1¼ in. high above the rail and 7 ft. 8¼ in. high from floor to ceiling. Its weight is about 30 tons, and it will accommodate 75 pas-sengers. The front is pointed, forming a "wind-split-ter" in which is the motorman's cab; the rear end is semi-circular. A curious feature is the use of 24-in. cir-cular windows, which are claimed to be air, dust and water proof, ventilation being supplied through roof fix-tures. The gearing is proportioned for a maximum speed of 50 miles an hour, and this has been attained in ser-vice; the low-speed gear is for 10 miles an hour. The car was built at the company's shops to the designs of Mr. W. R. McKeen, Jr., Superintendent of Motive Power, at Omaha, Neb.

WATER SUPPLY AND FIRE PROTECTION AT RICH-mond, Va., has just been reported on at length by the National Board of Fire Underwriters' Committee of Twenty. The supervision of the water-works is said to be satisfactory. The consumption is described as "rather large" and the pressures as "too low in some sections; in parts of the congested value district less than 40 lbs." The distributing mains are said to be too small throughout, the gridirooing poor, gate valves too few, hydrants too few in some residence sections and of unsatisfactory types, but well maintained. The faults in the distribution system make the water supply sub-ject to local interruptions, and thus the supply is "too limited at best to cope with serious fires." The fire de-partment is declared efficient, but it's standards should be raised. There is no building department, and such laws as exist are very inadequate but are well enforced. The conflagration hazard is severe, and the probable hazard high. The recommendations of the report in-clude, among other things, an extension of the high ser-vice water supply; the addition of a number of 30 to 12-in. mains; an addition of at least 2,000,000 gals. pumping capacity; an elevated tank of at least 1,000,000 gals. capacity; determination of the actual water con-sumption of the city as a whole and in its separate parts; reduction of consumption by stoppage of leaks in street mains, waste from defective plumbing and fixtures, and by extending the meter system or installing a house-to-house inspection or both. It is recommended that the fire department be changed from a 60% to a full paid basis; that every fire engine be tested thoroughly at least twice each year, and that the tests include "pump-ing for half an hour or more against a water pressure 100 lbs. in excess of the hydrant pressure"; that, when properly handled, fire engines should "maintain a dis-charge of at least 90% of their reasonable rating, develop more than 7% slip and disclose no serious effects." Numerous other recommendations are made in connection with the water supply, fire and building departments, electric wiring, the regulation of explosives and inflam-mables, and the conflagration hazard.

A NOVEL PLAN FOR EXCAVATING THE CULEBRA CUT.

By Fremont Hill, C. E.*

The writer has given much attention to the problem now before the United States in the excavation of the greatest amount in material in one mass that man has ever attempted to move—the cutting through the continental divide at Panama for the Isthmian Canal.

From his experience on the Chicago Drainage Canal and other important works, the writer is convinced that a better way can be found than the ordinary method with steam shovels and tracks, which engineers generally have assumed as the proper way to excavate the Culebra cut. That better way is illustrated in a general way in the accompanying perspective sketch; but before describing it let us see what the difficulties are with the steam shovel method.

It has been repeatedly stated by the responsible engineers of the canal work, that the problem at Culebra is not a problem of digging but of transportation. Put steam shovels enough on that 8-mile stretch and you can dig all that material out in a given number of years; but there must be cars ready to take that material away as fast as the steam shovels dig it, and the problem of hauling the full trains and the empty trains over the very ground which the shovels are steadily digging away, and of keeping all the shovels supplied with cars is a problem so complicated that no one can yet say just how it can be solved, or whether with the best solution possible there will not be a large amount of time lost by shovels and locomotives while track is being shifted and also on account of blockades and trains getting in each other's way.

Another matter of great importance is drainage. The rainfall at Culebra in about eight months of the year amounts to three times as much as falls in the eastern United States in a year. The Culebra cut will take the entire run-off from an area of land eight miles long and of a width much greater than that of the completed cut. This means, at every hard rain—and they come frequently—a whole river of water to be taken care of.

Lest it be thought that I am exaggerating on this matter, I quote the following extracts from the official report of Chief Engineer Stevens and of the Board of Consulting Engineers:

FROM REPORT OF JNO. F. STEVENS, CHIEF ENGINEER.

(Work being done by steam shovels.)

Observation and record seem to indicate that work can be successfully prosecuted during the dry season—about four or five months each year—and that during the remaining months—seven or eight—the constant rains will unavoidably cause such loss of time, due not only to cessation of work during actual rainfall, but from the effects of it in the cut and on the dumps, that it is seriously doubted whether during more than one-half of such rainy months work can be successfully carried on. In other words, our actual working year will be not one of twelve months, but of about eight or nine months.

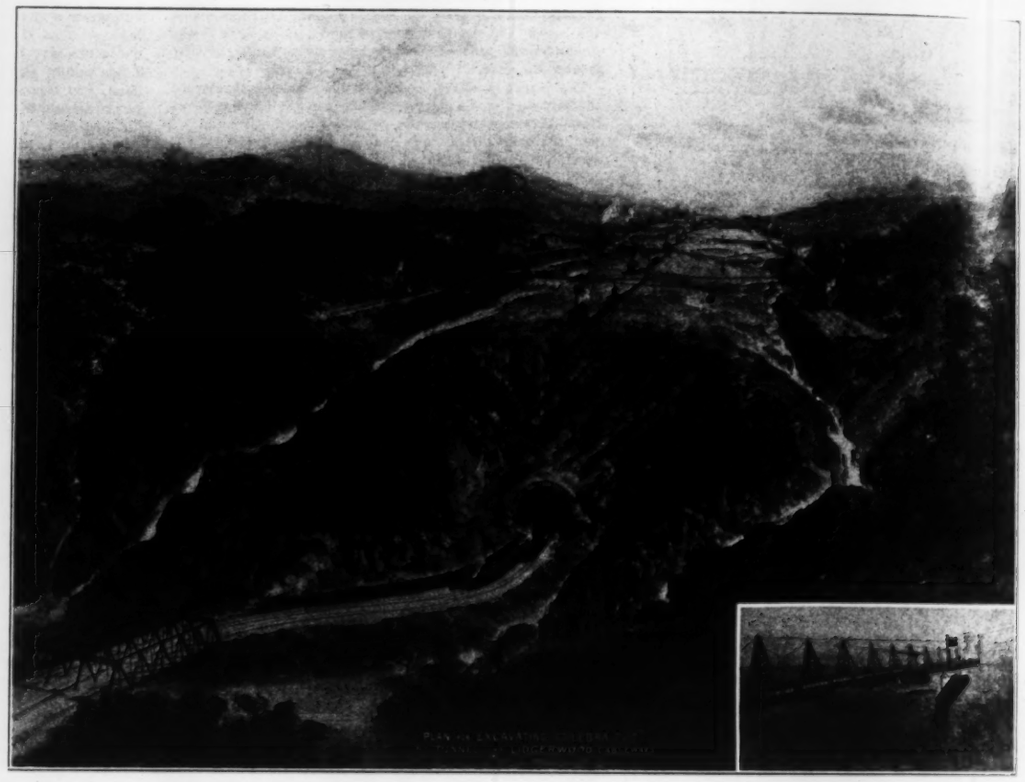
. . . .

The problem of Culebra cut is one of transportation (including disposal) pure and simple.

FROM THE REPORT OF THE BOARD OF CONSULTING ENGINEERS.

The Board recognizes that the removal of the material in the summit cut (Culebra) is in reality a problem of transportation. . . . this problem of transportation is in reality the substance of the problem of building the trans-Isthmian canal.

It is clear that for the best results the greatest possible amount of work must be done by mechanical appliances and the least possible by manual labor. It is equally clear that the methods of conducting the work, including the control of the plant and force, must be such as will be subject to a minimum of climatic interference and effect of rainfall in the rainy seasons. All parts of the cut must be completely drained so that the effect of rainfall and springs on the material to be moved may be reduced to the lowest limit.



THE TUNNEL AND CABLEWAY PLAN FOR EXCAVATING THE CULEBRA CUT FOR THE PANAMA CANAL.

Turning now to the plan which the writer has developed for obviating the above-mentioned difficulties. It is proposed at the outset to drive a three-track tunnel, from end to end of the projected cut, a distance of about eight miles. The floor of this tunnel would be at an elevation just above the surface of the natural water courses at each portal so that the tunnel will drain itself.

This tunnel would be driven from shafts, which it is proposed to sink at intervals of 1,200 ft. on the axis of the cut for its whole length. There would be 44 of these shafts, and this would give 90 working faces to drive the tunnel. Its construction, therefore, should be a very rapid process. The excavation of these shafts would determine absolutely the character of the material to be excavated for the whole of the cut.

In the completed tunnel (which would be lined) would be laid three tracks, the center track would be a loading track, the other two for the movement of trains in opposite directions.

On the surface, spanning the cut, would be up 44 double Lidgerwood traveling excavators, one to each shaft. Each is intended to excavate a 1,200-ft. section of cut, working 600 ft. each way from the shaft, and will be equipped with excavators and skips changeable to suit the material found.

At each shaft on the surface is a double track extending 600 ft. each way, equipped with cars, to bring the material received from the excavators to the mouth of the shaft, where it is dumped by a tipple down the shaft.

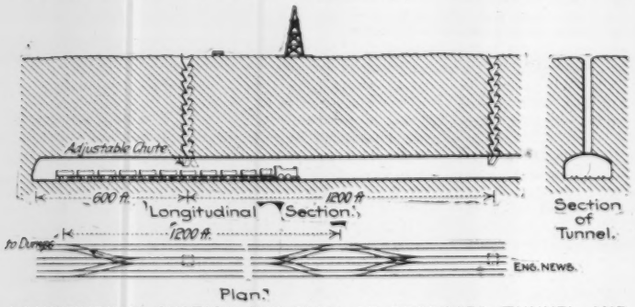
The shafts may be lined with baffles, so that the material will fall about 4 ft. between baffles and reach the skips on the cars, at the lower end, in the tunnel, without falling too fast. Or elevators may be employed to lower and dump the material.

The empty trains may enter the tunnel by the right hand track and switch each to its loading track 1,200 ft. long. The loading track is somewhat more than double the length of a train, so the engine can spot its cars successively beneath the shaft for loading.

When loaded the train will pass by the left hand track out of the tunnel and thence over the permanent track to the dump. Arrived at the dump the Lidgerwood unloading cableways—30 in number—will be arranged so that three trains—30 cars—can be unloaded simultaneously.

By loading into removable skips instead of directly into the cars, the tracks on the dumps are made permanent, and a great quantity of material can be deposited with no expense for track alteration.

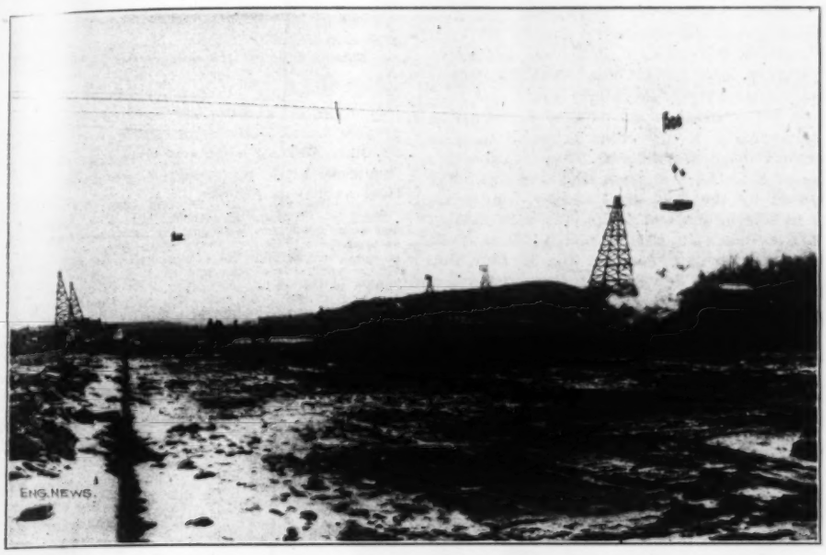
It will be seen at a glance how admirably this system solves the drainage difficulty. In working, the center, where the shafts are, is kept at its full height and the sides are worked down



LONGITUDINAL SECTION AND PLAN OF PROPOSED TUNNEL AND SHAFTS FOR CULEBRA CUT EXCAVATION.

*Cheseboro Building, 17 State St., New York City.

so that the rainfall drains to either side and runs off by gravity at the ends of the cut. The process of excavation is continued until the sides are lowered to a level as low as the tunnel tracks. Then a new through line of tracks is laid on each side and the cableways are used to deposit the material from the central ridge directly into the skips on the cars, the track through the tunnel being then abandoned or used for empty trains only.



BED OF THE ST. MARY'S RIVER LAID DRY BY COFFERDAMS. INGERSOLL-RAND ROCK DRILLS AND CHANNELER WORK. NOV. 16, 1905.

It will be apparent that the system is applicable whether a lock or a sea-level canal is built.

The entire plant is to be operated by electric power with current distributed from a central station at Panama, using crude oil for fuel.

The advantages of the system may be summed up as follows:

EXCAVATION.—A minimum number of men are used and they are nearly all housed and protected from the heat of the sun and the rains. A maximum amount of work is done by machine tools of tried and practical value. The plant will work every day and night in rainy season or dry season, giving a maximum of capacity and speed to completion.

TRANSPORTATION.—A perfectly built—permanent—double track railroad, level and as nearly straight as possible, extends all the way from cut to dumps, giving the cheapest and most rapid transportation possible.

DUMPS.—By the use of 25-yd. skips on the cars, and a battery of Lidgerwood cableways placed astride the tracks to lift the skips from the cars and carry them to the dumps, dump them and return them to the cars, all are the evils of settling fresh dumps—sliding and sinking tracks are done away with, and the material dropped from a height onto a bank will pound itself into a more solid embankment than by any other method.

Cableways similar to those proposed has been used with success on the Chicago Drainage Canal, the Hennepin Canal, the Croton dam and a great number of other important dams, and are now being used on a large piece of rock excavation in the St. Mary's River. Here a rock cut 300 ft. wide is being made in the bed of the river, which has been laid dry with cofferdams. There are four 10-ton traveling cableways hoisting skips which are loaded by 65-ton steam shovels. The cableways are able to handle material faster than the shovels can load it.

Regarding the cost of the work with cableways on the Hennepin Canal, the following extract from a letter dated Dec. 27, 1905, gives information of much interest:

Chicago, Dec. 27, 1905.

The records showing cost of operation and yardage are not very good for the reason that the conditions under which the plant was working are very unfavorable, and they would get much better records if the conditions were more favorable. The banks are constantly caving in, and the canal section raises up in the center, necessitating a great deal of moving of the plant, which takes up time and adds to the cost per yard.

Their records show that the first cost of the plant was $29,363.34. That the total operating cost to date has been $79,256.01. That the total yardage handled to date has been 526,534 yds. The total operating cost per yard to date has been 15.1 cts.

The total cost per yard to date has been 20.6 cts. per yd., but this figure takes into consideration the cost of the plant, and is gradually being reduced.

For the month ending Dec. 1, 1905, the yardage was 30,968; and the cost per yd. 15.9 cts.

The largest monthly output during the present year was for the month of July, 45,077 yds., at a cost per yd. of 10.6 cts. For the last 10 days of July they handled 16,257 yds., at a cost of 8.1 cts. per yd. The lowest cost per yd. during the present year was for the month of June, when it was 7.7 cts., and the largest monthly output for this year was for the month of August, 48,948 yds. at 10.7 cts.

Going back into last year, 1904, we find that in the month of August they handled 51,074 yds., at a cost of 6.8 cts., and in this same month for the 10 days ending Aug. 20th they handled 15,875 yds. at a cost of 5.9 cts. per yd.

During the year 1905 they have been digging harder material than the previous year, some of the material being hard pan, and this accounts for the cost being less per yard in 1904 when they were digging in peat. There has not been so much delay during the past year due to breakages, and the repairs have been very light compared with the year 1904, as during the first year they experienced a great deal of trouble with breakages of gears and engine shafts, which was entirely overcome by putting in a new foundation under the engine last winter.

In the first 10 days of this month they burned 65¼ tons of coal, at $2.25 per ton, and we understand that the most of these records are for three shifts of 24 hours of 8 hours each.

To give you an idea of what wages they are paying we submit the following list:

Chief engineer	$150.00	per mo.
One fireman	75.00	" "
" "	60.00	" "
Time keeper	75.00	" "
Survey man	75.00	" "
One engine man	125.00	" "
" " "	100.00	" "
" " "	90.00	" "
" " "	4.00	" day.
Blacksmith	2.50	" "
Rigger	2.25	" "
One foreman	2.50	" "
" "	60.00	per mo.

The highest price paid for common labor has been $2 per day, and from that down to 75 cts. per day, which we suppose is for a signal or water boy.

We think the lowest figures per yd. given above give a pretty good idea of the possibilities of such a plant working under favorable conditions, and without the high cost of repairs which were necessary on this plant, during the first year of operation.

The figures vary a great deal during the different periods of 10 days, and the plant was necessarily moved a great deal, back and forth, on account of caving in of the banks. For different periods of 10 days we find the cost per yd. to be as follows:

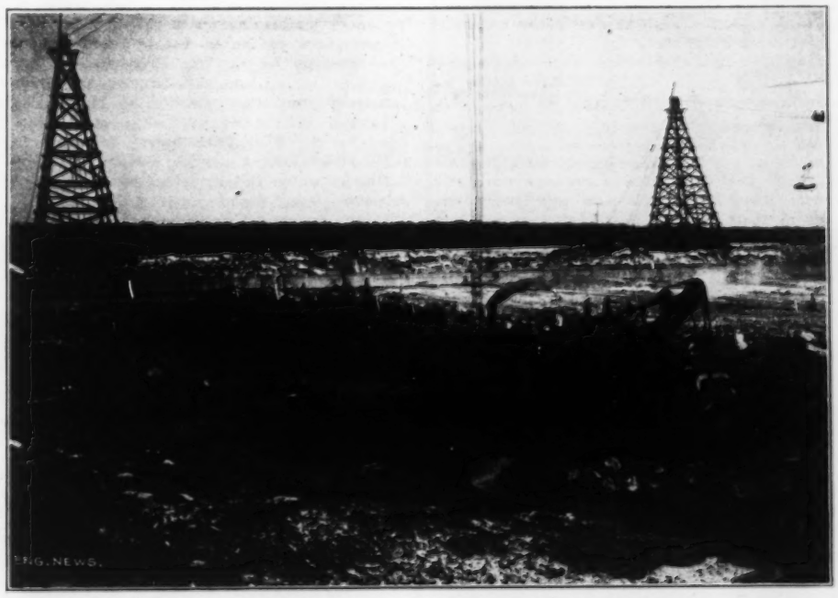
15.9 cts.	14.2 cts.	19.3 cts.	12.33 cts.	8.3 cts.	9.4 cts.
7.2 "	8.0 "	7.8 "	10.7 "	7.7 "	10.8 "
6.8 "	6.4 "	5.9 "	6.2 "		

The 15.1 cts. we gave above for the total operating cost to date tells the story, and taking into consideration the cost of the plant, this cost per yd. to date, as given above, is 20.6 cts.

In September, of this year, they put 1¼ cu. yd. buckets on the cableways on account of an increase in the length of span to about 600 ft., and also because of getting into harder material. And we notice in one of their reports they state they consider this was a good move. We also understand that last winter they put on new main cables, these cables being patent-locked Trenton rope.

All of the above repairs, we understand, are figures in the total cost per yd. to date, 20.6 cts.

In view of the above showing as to speed and economy of working, it is claimed that the cableway is at least deserving of careful investigation as a method of hoisting and conveying the material at Culebra.



EXCAVATING ROCK FROM BED OF ST. MARY'S RIVER. STEAM SHOVEL LOADING SKIPS TO BE REMOVED BY LIDGERWOOD CABLEWAYS.

EXPERIENCE WITH THE PRISM LEVEL ON THE U. S. GEOLOGICAL SURVEY.

By E. M. Douglas,* M. Am. Soc. C. E.

About five years ago officers of the United States Coast and Geodetic Survey devised a new kind of leveling instrument, which has since been used by that bureau for all of its precise levels. This instrument (Fig. 1) was described in detail in the annual report of that Survey for 1903, Appendix 3, and in Engineering News for July 2, 1903, in an article by Mr. John F. Hayford, M. Am. Soc. C. E., Chief of the Computing Division, U. S. C. & G. S. Its principal characteristics are: First, it is of the "dumpy" type; second, it is provided with a mirror over the level vial, and a pair of prisms so placed in a tube set parallel with the telescope that the position of the level bubble can be determined at any time by the levelman without moving his head from the eye piece; third, it has a micrometer screw for quick leveling under eye piece end of telescope; fourth, the level tube is placed very close to the line of collimation and is protected from sudden changes of temperature by an outer metal tube, which partially encloses the telescope also. The telescope is inverting, and has one vertical cross wire and three horizontal wires for stadia work.

These are essential features. Other less important ones are: The use of a nickel-iron alloy for the telescope tube and for other parts, which has a coefficient of expansion of about one-fourth that of brass. The level vial is chambered and

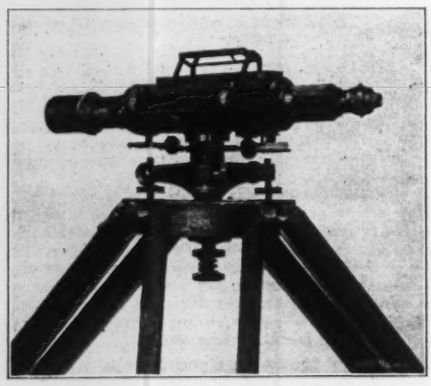


Fig. 1. The Prism Level, as Used on the U. S. Coast & Geodetic and Geological Surveys.

each division of $\frac{1}{12}$-in. represents an angular value of 2″. Three leveling screws are used, and the tripod is long enough to enable the levelman to stand erect while observing.

In the fall of 1904 this type of level was adopted by the United States Geological Survey for its precise lines, and the results were so remarkable that its use has been extended to the regular primary lines.

A half-dozen or more Geological Survey levelmen have used these instruments, over 1,500 miles of lines have been run, and every one speaks in their favor. For level lines of from 50 to 100 miles or more in length this style of instrument will, in the opinion of the writer, increase the output and accuracy over work done with the Wye level by at least 25%, and all engineers having to undertake such work are urged to investigate its merits.

The natural inquiry follows: What does it cost and how is it used? The instrument as illustrated in Fig. 1 costs in lots of five $200 each, which is considerably more than the cost of a Wye level.

For ordinary leveling, where extreme accuracy is not needed, some modifications may be made which will reduce the cost of the instrument without lessening its usefulness. The level vial can be non-chambered and ground for a 10″ interval; brass or bronze may be substituted for the nickel-iron alloy. These changes will probably reduce the cost by $25 or more. A desirable change, which will, however, increase the cost $7, is to fit the cross wires in a ring which may be revolved 90°, so that if used with a target rod there will be but a single horizontal wire in sight.

Rods of any kind can be used with this level, but "self-reading" or "speaking" rods will give increased speed and accuracy. The U. S. Coast and Geodetic Survey uses such rods graduated into meters and hundredths. The Geological Survey uses rods graduated into yards and hundredths. The smallest subdivision for either is therefore nearly $\frac{3}{8}$ in., which is found to be a convenient space to subdivide by estimation into tenths at a distance of from 300 to 400 ft. The rods used by the Geological Survey, which are 12 ft. in length, made of white pine with painted faces, are shown in Fig. 2, and a larger scale drawing of a portion of one in Fig. 3. Plumbing levels must always be used with these rods.

A form of note book devised for use with the yard rods is illustrated in Fig. 4. These books are 5½ × 8½ ins. in size and contain 80 double pages.

While working along a railroad, marked points on top of rails should be used for turning points. Away from railroads, steel turning point pins 10 ins. in length, with heads 2 ins. in diameter, having ¾-in. holes bored in them in which to rest the rounded ends of the rods, should be used. For instruments with the 2″ chambered levels, an umbrella shade is necessary. Without this it is practically impossible to hold the level bubble in the center of the tube.

For extensive work, a party consisting of one levelman, two rodmen, one recorder and one laborer is recommended. The recorder holds the umbrella shade, the laborer takes one of the rods if either rodman is disabled. A rodman should be competent to take the place of the recorder at times, and the recorder should be able to use the level if required, so that no time may be lost if one man is temporarily incapacitated.

In using the level, first firmly set the tripod in the ground with clamp screws loose. Tighten clamp screws, and closely level instrument with the leveling screws; point telescope towards the rod and clamp; while making final leveling with the micrometer screw, call out the yards and tenths touched by each of the three cross wires.

After exact leveling is made, repeat the yard numbers and tenths, and while holding the level bubble in center of tube by means of the micrometer screw, read also the hundredths and estimated thousandths for each cross wire, thus:

Rod readings.	Intervals.
2.739	.211
2.950	
3.161	.211

To check against errors in reading, the recorder immediately computes the difference between the readings as shown. The two differences agreeing within one or two thousandths are taken as proof that there is no blunder in the readings. With the particular stadia interval used by the Geological Survey this interval of 0.211 yds. taken as a whole number or 211 is the distance to the rod in feet (the focal length of telescope being disregarded).

If the computed intervals agree closely, the recorder calls out "all right," and the levelman then takes the remaining sights for the set-up, extra foresights being kept in the proper column. At the first opportunity the recorder adds together the three stadia readings for each sight, which at once gives the mean reduced to feet, for above reading 2.739 + 2.950 + 3.161 = 8.850 ft., or the same as the mean reading multiplied by three. The sums of backsights and foresights can be used in the regular way for computing H. I. or elevation, just as target rod readings are used.

By revolving the cross wire ring 90° and bringing the single vertical wire to a horizontal position, the instrument is perfectly adapted for use with a target rod. Used in this way, with a 10″ in. bubble, no recorder or umbrella holder is needed.

Although this style of level is not likely to lose its adjustment, yet it should be tested daily by the well-known "peg method," that is, readings are to be taken at two positions of level set up between rods about 300 ft. apart, first about 30 ft. ahead of the rear rod, then 30 ft. back of the front rod. From the four readings so secured compute a constant C from the formula:

$$C = \frac{\text{sum of near rod readings in feet—sum of far rod readings in feet.}}{\text{sum of dist. rod intervals in feet—sum of rod intervals in feet.}}$$

proper allowance being made for curvature and refraction for the distant rod readings. C is greater numerically than .005 for precise work or than .015 for ordinary work, an adjustment should be made by changing the position of the level bubble as follows:

Point to a distant rod with the bubble in middle of tube and read: Move the telescope (by micrometer screw) so as to raise the middle cross wire by an amount which is equal to C times the extreme wire interval in yards. While holding the telescope in this position, bring the bubble to the middle of the tube by raising or lowering one end of the level vial with the adjusting screw. If C is negative, the middle wire must of course be lowered on the rod, and after this adjustment has been made, its accuracy should be tested by redetermining the value of C.

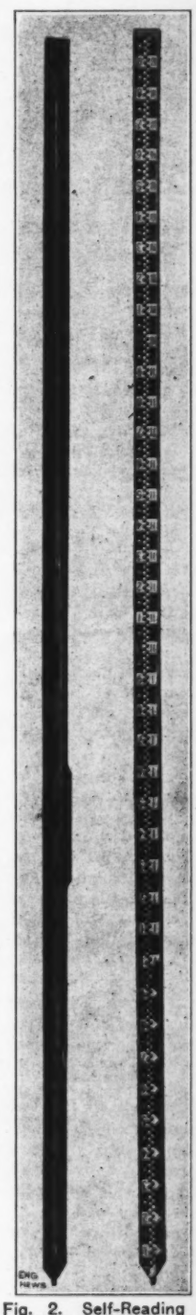


Fig. 2. Self-Reading Rod for Use with Prism Level.

General statements regarding the advantages of the prism level are of but little value without some facts.

The writer is prepared to show that working along railroads and using two velocipede cars for the men while moving from point to point and taking very few intermediate sights, over 18 miles of line have been run in one day between 6.30 a. m. and 5.10 p. m., including over an hour spent in setting bench marks or eating lunch, with an average length of sight of 308 ft., and none longer than 350 ft.

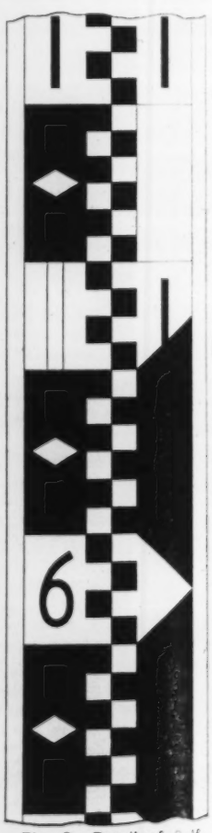


Fig. 3. Detail of Self-Reading Rod.

*Geographer, U. S. Geological Survey, Washington, D. C.

That on a number of occasions over 14 miles of line have been run in one day; that the output for several months has been over 200 miles each month; that single miles have been run in 15 minutes each, with no sight over 350 ft. in length; that for work away from a railroad a total difference of elevation of over 1,100 ft. has been made in each of two successive days in midwinter; that working in an ordinary rolling country with sights ranging from 75 ft. to 350 ft., 135 miles of line have been run in a month.

For the precise lines, which were all along railroads, the limit of allowable error in feet was .017 √ dist. in miles. This for a 25-mile run would be .085 ft. For the work off of railroads the limit of error in feet was .04 √ dist. in miles.

An accurate account of the cost of over 500 miles of line was kept. Including salaries and board for six men, transportation and incidental expenses, counting in all time lost from bad weather (in October, November and December), including also about 50 miles of line re-run because of closure errors more than the very rigid limit allowed, the cost per accepted mile run was almost exactly $3. Can any one show better results for any other style of level?

Neither this level, nor any other, will bring good results out of careless work. Therefore, to avoid blunders the same checks should be secured for prism level work as for that with other levels. With the self-reading rods, errors of one yard or one-tenth are most to be feared. A useful check against the first is found to be the use of a rod having the ground color for each yard different—black, red, green, orange. Before the levelman calls out the yard number, he calls out the yard color, the initial of which is recorded and verified by comparison with the yard number by the recorder. Errors of tenths in one reading may be overlooked if an error in subtracting for stadia intervals is made at same time. These may be detected by mentally multiplying middle thread reading by three and comparing product with the mean readings reduced to feet. Various other checks, such as have been found useful for Wye levels, should also be applied. The notes should be carefully checked each night. The Geological Survey uses a special book, into which elevations and descriptions of bench marks are copied each night.

It is probable that any one who is especially interested in the prism level can secure other useful information regarding it by addressing the Superintendent of the Coast and Geodetic Survey or the Director of the Geological Survey at Washington, D. C.

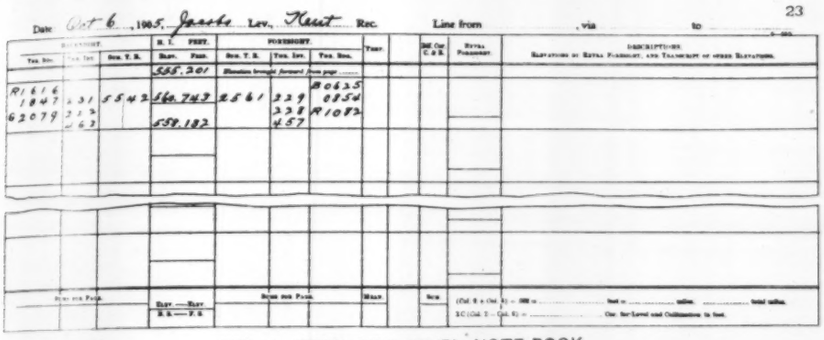


FIG. 4. FORM FOR LEVEL NOTE-BOOK.

THE DEFECTIVE CONDITION OF THE FIRE ALARM SERVICE OF MANHATTAN BOROUGH, NEW YORK.

During 1905 an exhaustive report on the character and needs of the fire alarm service of Manhattan Borough, New York City, was made for a special committee of the New York Board of Fire Underwriters by Mr. Kempster B. Miller, Consulting Electrical Engineer. The report has been published by the Underwriters, both in full and in abridged form. Some of its main features are outlined below. It may be noted, in passing, that a bond issue for making good the numerous radical defects of the system is proposed by the city authorities.

A sweeping condemnation of the fire alarm system of Manhattan appears on the first page of the abridged report, as follows:

As a result of this investigation, which was carried out with the utmost care into every essential detail, it has been found that the fire alarm telegraph system of the Borough of Manhattan is fundamentally wrong in design, and is in bad physical condition. It is not constructed in accordance with any proper engineering plans, and its physical condition is so bad that it must be characterized as being in an advanced stage of decay. It is liable at any time to such failures as to render it wholly useless to the fire-fighting department in the time of greatest need.

Faulty in original design and construction, the plant has deteriorated, and has been patched and repaired in its various parts as they, from time to time, became unworkable. The system long ago reached the stage where it cannot be transformed into permanent, proper working order by any further patching or even by radical repairs.

The only remedy for the conditions outlined above is the construction of a new system. After its completion the old one should be dismantled. Small portions of it, only, would be of any value except for junk.

The present fire alarm headquarters, at the central office on East 67th Street, "fails in every essential particular to comply with the proper requirements for such a building;" particularly in constituting one of several buildings in a solidly built block, in its non-fireproof character, in having its underground cables all enter the building at one point, and in having them pass through, in entering, a single manhole, an accident to which might cripple the whole fire alarm system.

About 77% of the cable of the Manhattan fire alarm system is not waterproof, and consequently is "in a hopelessly defective condition," making interruptions to the service liable at innumerable points. The cable layout is such that an interruption of one wire might throw 49 boxes out of service; a layout which would put out of commission no more than 10 boxes in case of interruption is advised. A large percentage of the fire alarm boxes are in very bad condition. Several boxes were found where the mere removal of the covers "opened or grounded some of the circuits." In other boxes, pieces of newspaper and other waste matter were found, and altogether the condition of the boxes was such, through the causes named, overcrowding of wires, and the like, as to make interruptions to the service liable. Inspection of manholes showed that in many cases "the fire alarm cables were strewn over the floors of the manholes or allowed to hang unsupported within them, so that the workmen employed there must necessarily tread upon them or in other ways cause their injury."

Some twelve miles of firm alarm cables are run in subways carrying high and extra high potential electric light and power cables. This, Mr. Miller states, is extremely dangerous, both on account of liability to interruption of the service and to danger of fires, including the possible burning of the central office.

A new central office is considered absolutely necessary. It should be entirely isolated from all other buildings. Preference is shown in the report for a location in the southern part of Central Park, but such a location is not definitely recommended. If it is not considered feasible to place the office in the Park, it is recommended that it be located between Sixth and Seventh Avenues and 54th and 55th Sts., and that in purchasing or condemning land a sufficient area should be secured to provide for an open space around the building. The size recommended for the office is 75 x 100 ft. in plan and a story-and-a-half in height. Further recommendations regarding the character of this building are as follows:

Nothing of a combustible nature should enter into its construction. It should not contain any gas pipes, boilers or other sources of explosive hazard. The floor or floors containing the electrical apparatus and exposed wires should be built at such a height above the ground that no possibility of a flood, due to a cloud burst, the breaking of a water main, or other cause, would be present. It should contain no skylights, and precautions should be taken to prevent its injury by falling matter from other structures as in conflagration or wind storms. Such precaution should be taken in the heating system and in the water supply as to prevent the possibility of any damage due to water or other causes to any of the electrical apparatus.

The building should be used solely for the purpose of the fire alarm central office, so that it would be occupied only by those charged with the duty of operating the fire alarm system and of maintaining it at all times in good condition.

The mounting of the apparatus in the new building "should be of slate or marble, supported on steel framework, as is now the general practice with respect to power switchboards in central stations in other lines of electrical industry."

The estimated cost of the new system recommended, omitting real estate, is $1,400,000, or, if 500 additional box stations were to be installed, $1,625,000.

Mr. Miller's conclusions are concurred in by Mr. J. J. Carty, Consulting Engineer, by the Committee of Twenty of the National Board of Fire Underwriters, and by Mr. J. C. Forsyth, Chief Inspector, Electrical Department, New York Board of Fire Underwriters.

THE TRANSANDINE RAILWAY was opened for traffic for 34 miles (first section) on Feb. 12. Consul Mansfield, of Valparaiso, Chile, reporting on the work, says:

From Juncal, the last station on the first section, to the summit is 9 miles, and the altitude increases from 7,221 to 10,365 ft. It is at this last height that the great tunnels are being opened to connect the Chilean and Argentine sections. The longest tunnel will be 3,405 yards long, of which 1,823 will belong to the Argentine section, and 1,582 to the Chilean. This tunnel is now in course of construction. It begins on the Argentine side at a point situated about 1 mile above Las Cuevas, which is at the foot of the summit. Between this tunnel and Juncal station there are 12 small tunnels, which have an aggregate length of 2,194 yds. It is believed that all of them will be finished in a year and a half, with the exception of that of the summit, which will require more time. The small tunnels are made for the purpose of protecting the line from avalanches or falls of snow. The first 3 miles of the second section are ready to receive the rails, and the construction of the remaining mileage is being rapidly pushed forward.

PRODUCER GAS ENGINE POWER has been adopted by the Norton Emery Wheel Co. for extending its present steam plant at Worcester, Mass. The horizontal double-acting, heavy duty type gas engine built by the Westinghouse Machine Co., of Pittsburg, Pa., has been adopted with Loomis-Pettibone producers using bituminous coal. The new gas engine will be 500 B. HP. rated capacity, direct connected to a Westinghouse 250-volt, 300-KW. generator running at a speed of 150 r. p. m. This unit will operate in parallel with two belted steam units, the entire plant supplying current to the various motor drives in the factory, and also for lighting. The engine will be of the tandem cylinder, single crank style, water jacketed throughout. Pistons will be supported practically clear from the cylinder by front, middle and rear crossheads. All valves are located directly in the cylinder body in a vertical line; inlet at the top and exhaust at the bottom. A sensitive governing system of the relay type places each inlet valve independently under the direct control of the governor, by which arrangement extremely close speed regulation is secured. Similar engines of this type of 3,500 HP. are now under construction for the Standard Steel Car Co., Butler, Pa designed to use blast furnace gas. At the Norton company's plant the gas used will be a mixture of two gases averaging about 125 B. T. U. per cu. ft. The producer process is intermittent, water gas being made during a short run, and "blast" or "air" being made while the producers are being blown preparatory to the succeeding water gas run. After a thorough cleansing in wet and dry scrubbers, the gas is sent to a holder of sufficient capacity to secure a thorough mixture of the alternating charges of the two different gases. In this plant a 20,000 cu. ft. holder will be used, sufficient to run the engine for about 26 minutes.

GAS PRODUCERS FOR POWER PURPOSES.

By Oskar Nagel.*

The earliest gas engines were used to furnish motive power for small industries, and employed illuminating gas as fuel. As larger gas engines came in demand, a cheaper gas was sought for. Dowson, an English engineer, was one of the first to construct a small producer for power purposes and thereby to start the development of our present gas power plants. In the Dowson producer a steam jet blower was used to draw a mixture of steam and air through the fuel. The gas was then cooled and washed by going through a waterseal. In using a mixture of steam and air the gas produced may have a composition about as follows:

CO_2 6.9, CO 26, CH_4 0.4, H 14, N 52.8.

By using air without steam we may obtain

CO_2 2, CO 29.4, H 1.9, N 66.9.

The thermal value of the second gas is about 20% less than that of the gas made with steam.

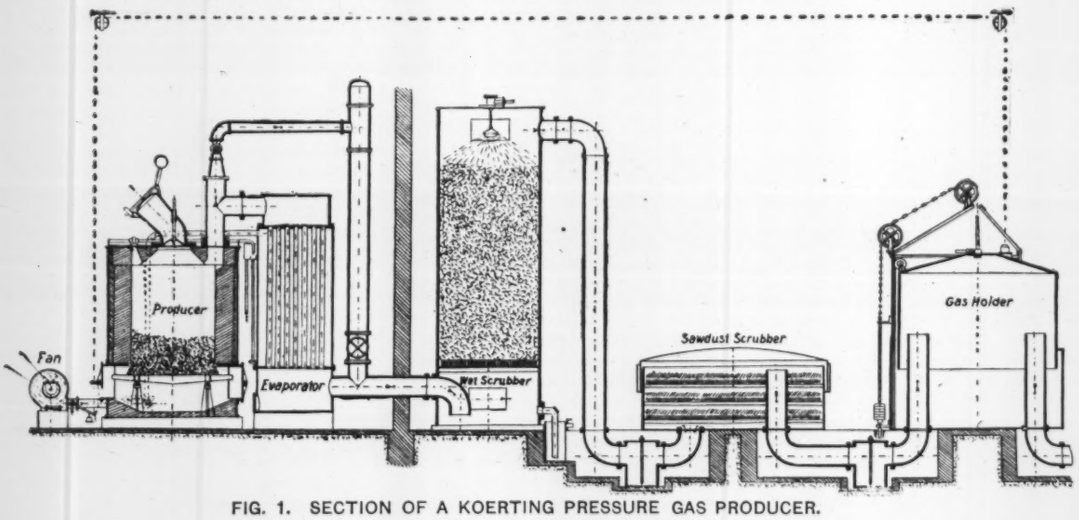


FIG. 1. SECTION OF A KOERTING PRESSURE GAS PRODUCER.

Thus by using steam with the air, CO is decreased and CO_2 increased, but the percentage of hydrogen is also increased, which means an increase of thermal efficiency. The quantity of nitrogen is considerably decreased also by the use of steam.

Another advantage of the use of steam is the lower temperature of the gas produced, and the cooler running and longer life of the producer.

Mond, the inventor of the so-called Mond-Gas-Process, went still further and added steam enough to produce a gas with H 27, CO 11, CO_2 16. This resulted in an extremely cool running of the producer, which is favorable for the reclamation of ammonia and for the prevention of clinkers. Dowson later added to his system a coke scrubber for purifying the gas and the essential elements of a successful producer plant were thus assembled.

Fig. 1 is a sectional elevation of a modern producer as made by Ernst Koerting, of Germany. The producer is a cylindrical shaft of wrought iron or steel plates lined with firebrick. The gas goes from the producer through an air pre-heater, heating the air to be used for combustion, then through a water-cooler in which the boiler water is pre-heated, then through a coke scrubber and lastly as a rule through a sawdust scrubber. If clean, hard fuel is used, the latter is not necessary, and with extremely good anthracite even the coke scrubber can be left out. It is essential that the purifying apparatus be made of liberal dimensions, as otherwise dirt is deposited in the engines, thereby causing shutdowns.

From the sawdust scrubber the gas goes to a small holder, which serves as an equalizer, but is not intended for storage. In the Dowson plants the holder was made of considerable size, but even then it was too small for starting the engine on account of the low efficiency of the producer gas.

For furnishing the steam for the steam jet blower a small independent boiler is provided. Regulation of the gas supply is effected by a connection from the holder to blower. The gas is under a certain pressure and can be tested as to quality at any time desired at a test cock. It burns with a blue-greenish or orange color. F. Fischer has found the efficiency of such a producer which, however, was running without air pre-heater, to be 82.8% of the heat contained in the coal. The average analysis of the gas was:

CO_2 7.2, CO 26.8, CH_4 0.6, H 18.4, N 47.

By using an air pre-heater this efficiency is increased about 9%. The boiler, however, causes a reduction of the efficiency, and in badly constructed generator plants the total loss may be as high as 25%. Tests made for a considerable length of time in Koerting's works showed only 9% of loss, due to the boiler, which amount about equalizes the gain produced by the air pre-heater.

Tests with the Koerting plant at the electric central station in Erlangen, Germany, have shown a fuel consumption per brake horse-power hour of 0.825 lbs. and per KW.-hour of 1.232 lbs. There are other disadvantages of the boiler besides the loss in fuel economy. If the boiler is done away with we can do without a licensed engineer and constant attendance. On the other hand, the boiler is a very convenient means for starting up.

The first gas producer plants of large size without a boiler were installed about twelve years ago by Lencauchez, in Paris, and vicinity. A fan was used in these plants for moving the air through the fuel. Benier, of Paris, was the first to suggest that the sucking action of the engine piston might be used for drawing the air of combustion through the producer. Shortly after this suggestion Gebr. Koerting undertook a large number of tests and experiments in this matter and obtained patents on this system. These so-called suction gas producer plants have lately attracted wide attention. Naturally these plants cannot be worked without addition of steam or water, to the air of combustion. Lencauchez injected water under the grate while in the later constructions the heat of the gas produced is utilized for generating the necessary steam. The air is generally not pre-heated.

It may be asked whether the quantity of steam generated by the heat of the gas produced is sufficient. Assuming that the gas leaves the producer at about 850° and is cooled by the evaporator to about 300°, 1 cu. ft. yields about 10 B. T. U., 1 lb. of carbon yields 86 cu. ft. of gas, which means that we have about 860 B. T. U. at our disposal for every pound of carbon burned in the producer, and this heat will evaporate about 0.75 lb. of water.

With complete decomposition 0.7 are required per lb. of carbon, bu by radiation is unavoidable, suc ducers generally runs somewhat those having an independent su Even in the suction type of prod is an absolute necessity for blowi until the gas is of satisfactory engine cannot be started before reached.

Fig. 2 shows a Koerting suction plant comprising producer, evapo scrubber. There is no fundame between suction and pressure The holder in the pressure syst clusively, as above stated, as an equalizing space has also to be p suction system by some kind of tank which eventually can also serve as a sawd purifier.

The grate of a suction producer can be cleaned while the producer is running, which cannot be done in the pressure type. However, a thorough cleaning of the producer from clinkers settling on the brick lining can only be performed during a period of shut-down.

In the suction type, we have a negative pressure, which absolutely prevents any leakage of gas to the atmosphere, as compared to pressure plants. A leak in the suction pipe line causes an inflow of air and deteriorates the gas, which can be readily noticed at the engine.

If a very good grade of anthracite is used, the sawdust purifier is not necessary, and the plant becomes very compact, as shown in Fig. 2. Several builders are using, especially for the smaller sizes, an evaporator on top of the producer in place of the independent evaporizer. Liberal dimensions throughout the apparatus are naturally essential in these plants.

In suction gas plants, the engine receives the gas at a negative pressure, which varies with the load. The air pressure, however, being constant, regulation of the amount of air drawn into the cylinder is necessary. This is generally done in a rather crude way; but it might be done automatically by an accurate mixing valve, such as is used on the Koerting 4-cycle engine.

In many factories gas is desired for other purposes beside power production. In Germany, therefore, many plants are in use in which a blower forces air continually into the producer independent of the engine suction. The power required for a fan in a 100 HP. plant is about ½ HP. The fan can also be inserted behind the producer, thereby leaving the producer under suction and allowing the cleaning of the fire during working hours. Compared with suction gas plants these plants have the advantage that a smaller size of coal and fuel of lower quality can be used.

Illuminating gas is certainly the most convenient means for driving gas engines, as a producer-gas power-plant means higher first cost and certain inconveniences. But in plants from 50 HP. upwards, the saving by using a producer plant is such that the advantages considerably outweigh the disadvantages. Compared with steam plants the total absence of smoke is to be mentioned, besides the large saving in fuel and running expenses.

For power plants up to 250 HP., under ordinary conditions, suction producers are to be recommended, while from 250 to 500 HP. the pressure producer is to be preferred. For plants larger than 500 HP. several units have to be installed.

Altogether, over 4,000 Koerting producer-gas installations are in actual use in Germany.

*De La Vergne Machine Co., Foot of E. 138th St., New York City.

HOW THE TECHNICAL MAN CAN WIN ADVANCEMENT.

By H. J. Hapgood.*

The success or failure of the technical man often hinges upon the line of work he takes up. Men frequently get into lines for which they are ill adapted, or in which there is limited opportunity for advancement, and before they fairly realize their mistake, they are too old to take up anything new. The present unprecedented demand for all kinds of technical men is responsible for a good many of these misfits. It is so easy to get work of some sort that there is great temptation to seize upon the first good salary that offers, regardless of a man's real interest in or fitness for the position.

Enthusiasm is essential to success in any work and the technical man who finds his interest beginning to wane should not hesitate to make a change. There is on record a case of one engineer who won marked success in spite of the fact that his heart was not in his work. To be an artist had always been his secret ambition, but his parents forced him to attend a technical school, and although he is said to have hated the sight of a blue print and everything else connected with engineering, he went grimly ahead and gained not only wealth but fame. His case, however, is unusual, and few men can afford to take such a chance.

To be successful the technical man must find a line of work which he likes and which is not over-crowded. It is the pioneers in new branches of business or technical work who achieve the greatest success. Men who entered the steel business twenty or twenty-five years ago had exceptional opportunities from the fact that the methods of manufacture were still very crude. The business was badly in need of development and offered the technical man of brains and energy a hundred times the chance that it does to-day.

Concrete construction, gas engines, producer gas, conveying machinery—these are some of the engineering lines which are at present undergoing rapid development, and which seem to offer exceptional opportunities to men of the right brains and energy. In concrete construction alone there is difficulty in finding enough men with the right experience to handle the large amount of work in this line which is being done.

Two kinds of technical men are especially in demand to-day—the specialist and the man who combines with his technical knowledge executive or selling ability, or both. Of these kinds of men there is a great scarcity, and they command large salaries. The technical man should make a choice as early as possible between straight technical work and the business end, and shape his course accordingly.

Undoubtedly the combination of business and technical ability is rarest and commands the highest salary, and if a man feels that he can sell goods or get results out of other men, he should not fail to develop his talents in these directions. Hundreds of technical men have failed to reach the limit of advancement possible for them owing to lack of business ability.

Only recently an expert designer resigned from the employ of a large engine manufacturing company because a younger and less competent man had been promoted over his head to the position of chief engineer. The designer thought himself competent to fill the place; but as a matter of fact he was not. His employers had tried him in it several times, and he had invariably failed. Although he knew the business thoroughly and was one of the most competent men in his line in the country, he lacked the faculty of getting results from others.

The opportunities for the technical salesman are well illustrated by the case of a man who is now selling heavy machinery through the Middle West. Two years ago he was holding the position of chief engineer at a salary of $3,500. He thought he was capable of earning more, but found that he had reached his limit so far as the line he was in was concerned. He decided to take up selling work, and started with his present employers at a salary of $2,000. He made good from the start, and to-day he is earning in salary and commissions over twice what he did as chief engineer.

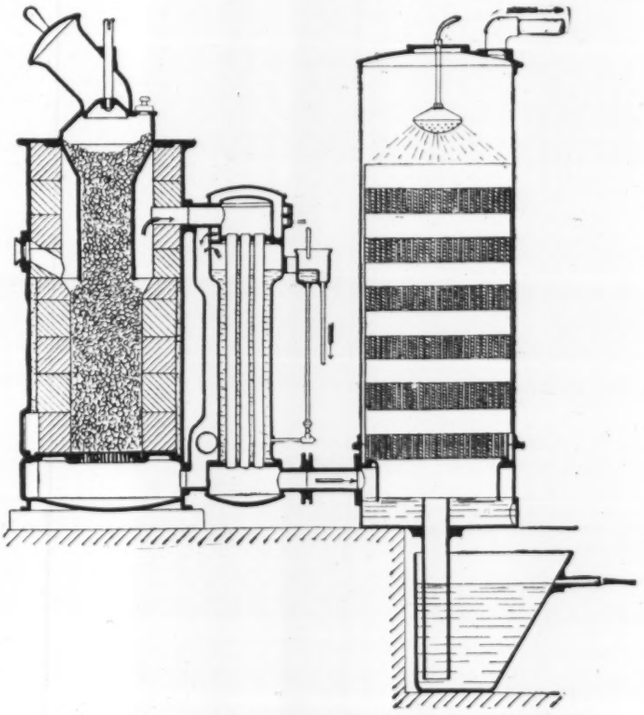


FIG. 2. SECTION OF KOERTING SUCTION GAS PRODUCER.

The technical specialist most in demand is not the one who is familiar with only one branch of work. It is rather the one who is master of some one line and also has a good general knowledge of associated lines. Nowadays a man must specialize, but the more he knows about the branches associated with that in which he has specialized, the better his chances of success.

When the president of a large electrical manufacturing company wanted a chief engineer recently, he hired a man from a rival concern. Some one asked him why he did this when he had in his employ so many competent men. His reply was that all the men in his own establishment with anything like the right qualifications for this position had specialized too much. "They know more about some one line," said he, "than the man I have hired, but they have not the broad general knowledge which he has. What I want in the position of chief engineer is an all around man who can not only design electrical machinery but can build and operate it as well. It is with this idea in mind that I make the young technical graduates whom we hire work for a year or two in various departments in the shop and drafting rooms, before allowing them to specialize."

If your position does not permit of broadening out in this manner, you can often accomplish the same results by home study and personal observation. Right here, by the way, is where many technical men, with the brains, the ability and the training necessary for great success, fail to rise above the level of mediocrity. They lack the capacity for hard work, which is even more essential for them than any other class of workers.

All the technical branches are advancing so rapidly that no matter how good a man's preliminary training may be, unless he has the energy and ambition to work and study outside of business hours he is soon left far behind the times. No field of work requires the constant study and close application which the technical man must give to achieve even partial success. One of the leading consulting engineers in the United States says that he never reads a book or publication of any kind except those pertaining to his work. "I do not do this from preference," he says, "I am forced to it by the fierceness of modern competition and the rapid development of engineering. If I stop even for a few months the work I do outside, I don't see how I would ever be able to catch up with my competitors."

If proof of the need for persistence and energy were lacking it would be found by studying the careers of technical school graduates. Time and again you will find that the men who led their classes, who seemed to have the greatest natural ability and who were apparently sure to make a mark for themselves in the technical world were never heard of five years after their graduation, while less capable men who had difficulty in attaining satisfactory rank in the course are often found high up in their profession. Genius, ability and educational training are of little use unless backed by capacity for hard work.

One of the most brilliant engineers in the United States, whose advice is sought by scores of large corporations, offers a good case in point. It took him four years and a half to complete a course which should have taken but four. He was badly handicapped by a poor personality. He was slow to think, often inaccurate and in many other ways apparently quite unfit for engineering work. Yet, he is to-day earning an income two or three times larger than that of any other man in his class at college and he has at work in the drafting room the salutatorian and the valedictorian of that same class.

"The successful engineering man is practical instead of theoretical," said this man, when asked to what he attributed his success. "He not only knows how to do things but he knows how to do them economically. In fact, a good definition of a capable engineer would be a man who can make one dollar do the work of two. The professors at the college where I studied tell me that I was none too well supplied with theory when I received my diploma, but if I do say it, I did know how to put what little theory I had into practice and I was not afraid of long hours. I think I could almost sum up the secret of my success in two words—hard work."

A NEW WATER POWER ELECTRIC PLANT owned by the San Joaquin Light & Power Co., of Fresno, Cal., was put in operation April 16. The conduit supplying water for the above plant has a total length of 4.3 miles and comprises open canal, tunnels, flumes and pipe line. The above structures are designed for a flow of 100 cu. ft. per second and with the total head of 400 ft. give a total capacity of 3,600 HP. The canal is 5 ft. wide on bottom and 3 ft. deep with side slopes 1 on 1. It is lined throughout with concrete. The intake basin and the fore-bay are concrete structures and the tunnels are also lined with concrete. The flumes are of steel plate ⅛-in. thick, semicircular in form and 6 ft. wide. The pipe line is 3,000 ft. long and 52 ins. in diameter; the thickness of steel varying from 3/16-in. to ¼-in. The water-wheel units (two in number) are of Doble tangential type and develop 83% efficiency under full load. The electrical units are of Bullock design, furnished by the Allis-Chalmers Co. The plant is situated on the North Fork of the San Joaquin River in the Sierra Nevada Mountains, about 50 miles northeast of Fresno. Construction was commenced in May, 1905, and has been somewhat delayed by the fact that all material, except lumber, was transported into the mountains on freight teams. This is the second plant this company has constructed; the original plant is to be reconstructed and enlarged and there are plans for other new plants. Mr. A. G. Wishon is Manager, Mr. G. O. Newman is Chief Engineer, and Mr. Rolf R. Newman is Assistant Engineer, with headquarters at North Fork, Madera Co., California.

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*President of "Hapgoods," 309 Broadway, New York City.

A PAGE BASCULE BRIDGE AT SAN FRANCISCO, CAL.

The extensive terminal improvements at the China Basin, in San Francisco, by the Atchison, Topeka & Santa Fe. Ry., necessitated the construction of a drawbridge to carry Third St. across the navigable channel. This bridge was built for the city at the railway company's expense, and has been turned over to the city authorities. After considering various plans, the railway company's engineers recommended the adoption of the Page type of bascule bridge, and this was approved by the Board of Public Works on behalf of the city. As the floor of the bridge is only 5 ft. above high tide, it was necessary to employ a bridge of the through type, and this is the first Page bridge built with through trusses, although the Ashland Ave. bridge over the Chicago river was originally intended to be of this type, as shown by the drawings published in our issue of April 25, 1901. The plans for that bridge were afterwards changed, however, and a deck span built, which was illustrated in our issue of Jan. 1, 1903. The San Francisco bridge differs materially from the Chicago through-truss design above mentioned.

The bridge is of the trunnion type, with two leaves, and has a length of 113 ft. c. to c. of trunnions, giving a clear channel width of 75 ft., as the bridge crosses the channel at an angle of 77°. There is a roadway 36 ft. wide and a single sidewalk 8 ft. wide. All movable parts are theoretically in balance during operation, the power required being only that necessary to overcome friction and wind pressure. The special feature of the design is in the counterweighting and the method of operating. The counterweights are carried level with the upper part of the trusses, and swing down towards the roadway level as the bridge opens; and it must be admitted that the arrangement, however advantageous or satisfactory mechanically, is anything but satisfactory as far as appearance is concerned. Our readers may form their own opinions as to this from the accompanying elevation and view.

The counterweight for each leaf of the bridge is composed of a framework carrying the operating machinery and suitable weights, the framework being hinged to pins or fixed supports on the abutments and having its front or channel end supported upon the tails of the trusses. The arrangement is shown in the elevation, Fig. 1. The girders, A, A, carrying the counterweights are parallel with and on each side of the trusses, and hinged to 10-in. pins at the tops of the heavy columns, B, which are anchored to the abutment. These girders are 29 ft. long and 9 ft. deep. At the forward end each pair of girders carries a 14-in. shaft, C, having at the middle a 30½-in. operating pinion, which gears with the rack on the face of the track or operating girder, D. The shaft also carries two 4 ft. bearing wheels, one on each side of the pinion; these ride on the face of the track girder, D, and transmit the load of the counterweight to it. On the end of the shaft is the main spur wheel, connected by a train of gearing with the motor, E. The motors and gearing are supported on longitudinal girders, F, connected to transverse beams, G, which are riveted to the inner counterweight girders, so that the machinery and its supporting framework, together with the girders, form a part of the counterweight system. The necessary additional weight is made up by cast-iron blocks bolted to the webs of the outside girders, A, and by concrete filling on a buckle-plate flooring riveted to the machinery framing. The weight is so distributed as to give a practically equal load upon all the rollers.

In Fig. 2 is shown the ponderous heel section of one of the main trusses, with the trunnion bearing and the track girder with its operating rack. Fig. 3 is a view of the completed structure.

Each leaf of the bridge is operated by two 40-HP. electric motors, each pair connected to a series-parallel controller in the operator's tower at the north end of the bridge. This tower is supported by a lattice girder between the columns, B, and submarine cables laid across the channel afford the necessary connections with the motors of the south leaf of the bridge. An electric indicator with a number of lamps shows the position of each leaf during operation, the lamps being lighted and extinguished by means of specially designed contact devices connected mechanically to each leaf. The same contact devices are also connected to circuit breakers and automatically shut off the current when the bridge reaches its limit of travel in either direction. This is particularly desirable as the operator has no view of the south leaf when the bridge is raised. Each motor is provided with a magnetic brake, which is normally applied, and is only released by pressure of the operator's foot upon a switch in the floor of the tower. The center-lock is of the bar or plunger type, moving longitudinally, and is operated by a 3 HP. motor at the end of the north leaf, the position of the lock being shown by an indicator similar to those above mentioned. Signal lamps are placed at the end of each leaf as a warning to vessels and to show the position of the leaf when raised. The bridge has been in use only a short time, but tests show that each leaf required about 35 HP. for operation with the motors running in multiple, the time consumed being about 24 seconds. With the motors connected in series, the power was less than 20 HP. and the time was [illegible] seconds.

The substructure consists of two concre[illegible] ments of channel shape, each having a fr[illegible] and two wings. The borings for the fou[illegible] showed about 25 ft. of mud, underla[illegible] moderately hard mixture of sand and [illegible] each abutment a cofferdam of Wakefi[illegible] piling was built, the soft material was [illegible] out with a clamshell bucket, and the pi[illegible] then driven and cut off. The lower par[illegible] concrete was laid in water, the water be[illegible] pumped out and the rest of the conc[illegible]

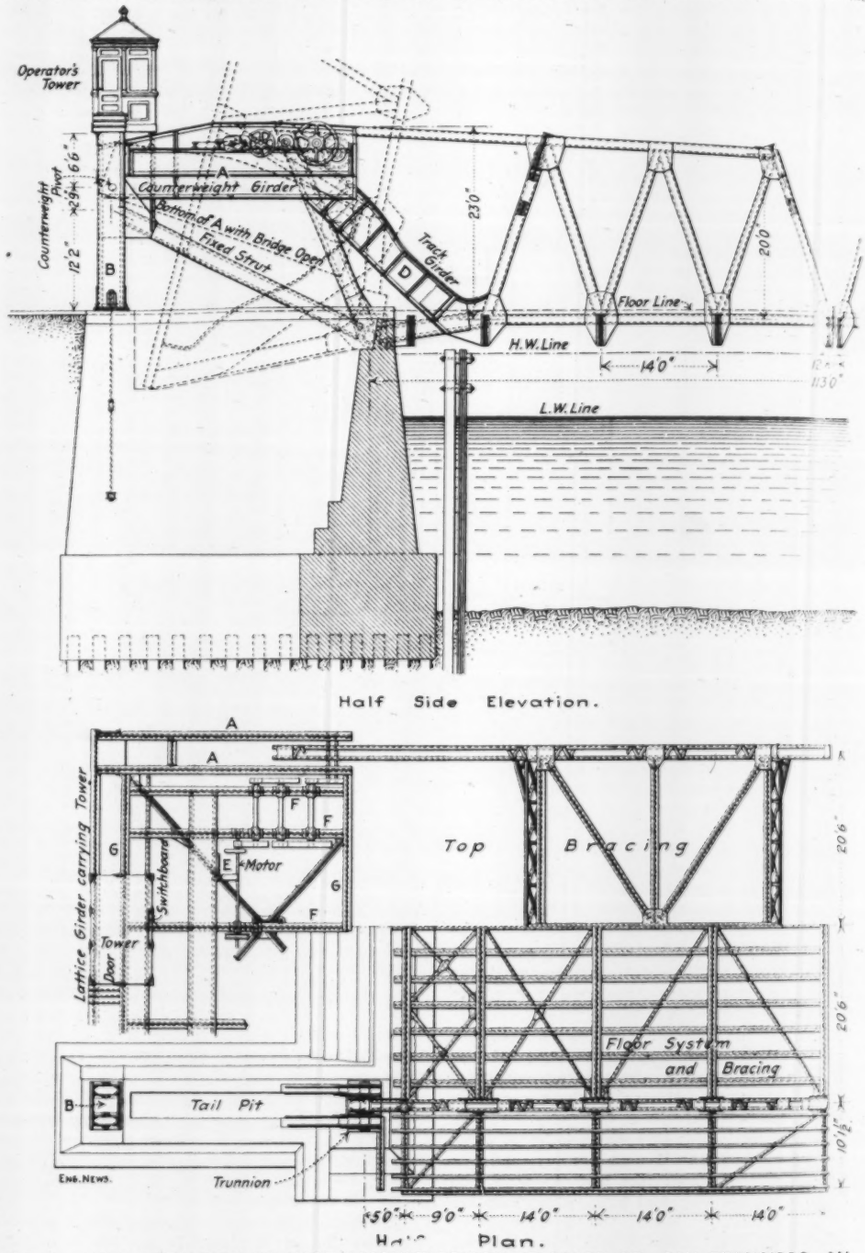

FIG. 1. HALF ELEVATION OF PAGE BASCULE BRIDGE AT THIRD ST., SAN FRANCISCO, CAL.

In the dry. In the night of Dec. 9, 1901, when only the south abutment had been built, an earthquake shock caused a 3-in. crack at the intersection of the abutment and the west wing, the rear end of the wing settling about 4 ins. and also moving out about 4 ins. To determine the condition of the foundation, this end of the wing was loaded with 65 tons of steel rails, which remained in position for about a month. As no further settlement had then occurred, the crack was filled with cement grout, tie rods were put in to prevent any further movement, and the wall was then leveled up to the proper elevation and made ready for the superstructure. In the recent earthquake, the two abutments were

pushed forward 8 or 10 ins., raising the leaves so that the ends were 5 or 6 ft. above the horizontal and hammed together so that they could not be lowered. No electric current being available the leaves were raised by block and tackle operated by steamers, and as soon as they were released a further movement of about 1¾ ins. occurred in the abutments. The exact amount of movement of the abutments cannot be determined for some little time as all level marks have been shifted or destroyed. Heavy struts are to be placed between the abutments, below the bed of the channel, and for the superstructure it is proposed to remove the end posts and end floor beam of one leaf, cut off the bottom chords and floor joists the necessary amount, and replace the floor beam and end posts, the latter being then at a slightly smaller angle than as originally built.

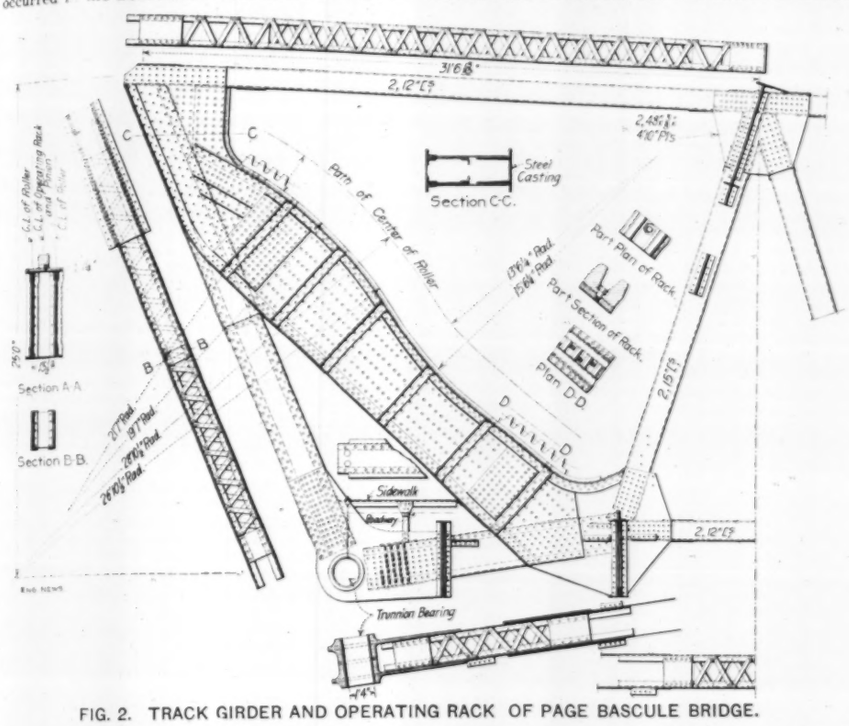

FIG. 2. TRACK GIRDER AND OPERATING RACK OF PAGE BASCULE BRIDGE.

The bridge was designed by Mr. W. M. Hughes, M. Am. Soc. C. E., of Chicago, under the Page & Shnable patents, and subject to the approval of Mr. A. F. Robinson, Bridge Engineer of the Atchison, Topeka & Santa Fe. Ry. System. Mr. W. D. Nicholson, Assistant Engineer of the railway, had charge of the construction. The Thomson Bridge Co., of San Francisco, had the contract for the substructure and the erection of the superstructure, the steel work for the latter being built at the Lassig (Chicago) shops of the American Bridge Co. The electrical equipment was installed by Geo. P. Nichols & Brother, of Chicago.

PRESENT CONDITIONS ON THE PANAMA CANAL WORKS.*

THE WATER SUPPLY.

One of the first things brought to my attention upon arrival on the Isthmus was the condition of the water supply at Colon. Chief Engineer Stevens reported that the present dry season had extended over a longer period than any other during the past 25 years. As a result streams available for water supply were lower and the fear of a possible water famine greater than for many years. While the reservoirs supplying the districts of Panama, Empire, Gorgona, and Bas Obispo contained sufficient water for many months to come, the stock of water in the reservoir supplying the district of Colon had become reduced to 1,500,000 or 2,000,000 gallons. Therefore as a means of impressing upon persons residing in that district the danger of extravagant use of water, Mr. Stevens equipped a water train, erected three temporary water stations in the Colon district, and began hauling into that district 250,000 gallons per day for daily consumption, holding the supply in the reservoir for a possible emergency. This means of adequately meeting the daily needs will be continued until the rainy season again provides an exhaustless supply through the use of the reservoir system.

*Condensed from a Special Report made by the Chairman of the Isthmian Canal Commission to the Secretary of War on April 23.

HEALTH CONDITIONS.

Under the direction of Governor Magoon health conditions on the Isthmus are most satisfactory. Notwithstanding the fact that there are more employees and their dependents on the Isthmus than ever before (the monthly pay rolls showing from 22,000 to 23,000 employees with a daily effective force of about 16,000 or 17,000) there were fewer patients in hospital than for many months past. Doctor Gorgas reported 450 beds vacant in hospitals. There has been no authentic case of yellow fever since last November. Mosquitoes are so scarce that many persons sleep in unscreened houses, and discard mosquito netting without incurring personal discomfort. Doctor Gorgas is sanguine that he has the health situation so well in hand that no epidemic can arise within the Canal Zone. The danger can come only from the outside. As an evidence of the general health conditions Doctor Gorgas stated the rate of sickness was only 20 per thousand.

FOOD AND QUARTERS FOR EMPLOYEES.

The building department has not only provided ample quarters for the existing force, but at this time has a reserve sufficient to accommodate 3,000 additional laborers. It has also provided suitable quarters for all American employees who may now be living in Commission houses, except in isolated cases where economic and other conditions may make a change undesirable.

Under the direction of Chief Engineer Stevens, through the labor and quarters department, and the commissary of the Panama Railroad, the policy adopted to provide suitable food at reasonable prices, while not yet satisfactorily effected, has nevertheless made great progress. So far as the common laborers are concerned, uncooked food is obtainable at reasonable prices from the commissaries of the Panama Railroad. Mess kitchens have been created at the different labor camps, where wholesome and nourishing meals may be obtained by such laborers at a cost of 10 cents each, and at this price a small marginal balance in favor of the Commission is left.

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Nine large mess houses (or hotels) are maintained at as many different points along the line, where nourishing meals are served in clean surroundings, at a cost to employees of 30 cents each.

In addition to the maintenance of these mess houses (or hotels) the American employees are permitted to buy uncooked food supplies from the commissaries of the Panama Railroad, and may also secure meats and other perishable foods through the medium of the line of refrigeration above mentioned. The charge to employees for such supplies is that paid by the Commission, plus a fixed percentage to cover the expense of transportation and distribution.

In this connection particular mention should be made of the Tivoli Hotel, situated on Ancon Hill, containing 160 sleeping apartments, many of them with private baths. The structure is completed and the hotel will be ready for occupancy as soon as the interior fittings and furnishings can be installed.

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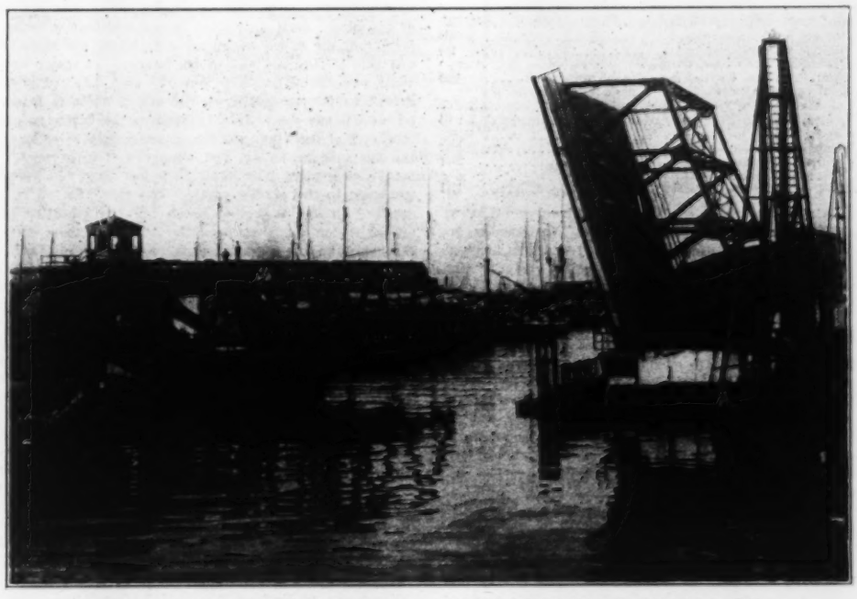

FIG. 3. THE PAGE BASCULE BRIDGE AT THIRD ST., SAN FRANCISCO, CAL.

A PAGE BASCULE BRIDGE AT SAN FRANCISCO, CAL.

The extensive terminal improvements at the China Basin, in San Francisco, by the Atchison, Topeka & Santa Fe. Ry., necessitated the construction of a drawbridge to carry Third St. across the navigable channel. This bridge was built for the city at the railway company's expense, and has been turned over to the city authorities. After considering various plans, the railway company's engineers recommended the adoption of the Page type of bascule bridge, and this was approved by the Board of Public Works on behalf of the city. As the floor of the bridge is only 5 ft. above high tide, it was necessary to employ a bridge of the through type, and this is the first Page bridge built with through trusses, although the Ashland Ave. bridge over the Chicago river was originally intended to be of this type, as shown by the drawings published in our issue of April 25, 1901. The plans for that bridge were afterwards changed, however, and a deck span built, which was illustrated in our issue of Jan. 1, 1903. The San Francisco bridge differs materially from the Chicago through-truss design above mentioned.

The bridge is of the trunnion type, with two leaves, and has a length of 113 ft. c. to c. of trunnions, giving a clear channel width of 75 ft., as the bridge crosses the channel at an angle of 77°. There is a roadway 36 ft. wide and a single sidewalk 8 ft. wide. All movable parts are theoretically in balance during operation, the power required being only that necessary to overcome friction and wind pressure. The special feature of the design is in the counterweighting and the method of operating. The counterweights are carried level with the upper part of the trusses, and swing down towards the roadway level as the bridge opens; and it must be admitted that the arrangement, however advantageous or satisfactory mechanically, is anything but satisfactory as far as appearance is concerned. Our readers may form their own opinions as to this from the accompanying elevation and view.

The counterweight for each leaf of the bridge is composed of a framework carrying the operating machinery and suitable weights, the framework being hinged to pins or fixed supports on the abutments and having its front or channel end supported upon the tails of the trusses. The arrangement is shown in the elevation, Fig. 1. The girders, A, A, carrying the counterweights are parallel with and on each side of the trusses, and hinged to 10-in. pins at the tops of the heavy columns, B, which are anchored to the abutment. These girders are 29 ft. long and 9 ft. deep. At the forward end each pair of girders carries a 14-in. shaft, C, having at the middle a 36½-in. operating pinion, which gears with the rack on the face of the track or operating girder, D. The shaft also carries two 4 ft. bearing wheels, one on each side of the pinion; these ride on the face of the track girder, D, and transmit the load of the counterweight to it. On the end of the shaft is the main spur wheel, connected by a train of gearing with the motor, E. The motors and gearing are supported on longitudinal girders, F, connected to transverse beams, G, which are riveted to the inner counterweight girders, so that the machinery and its supporting framework, together with the girders, form a part of the counterweight system. The necessary additional weight is made up by cast-iron blocks bolted to the webs of the outside girders, A, and by concrete filling on a buckle-plate flooring riveted to the machinery framing. The weight is so distributed as to give a practically equal load upon all the rollers.

In Fig. 2 is shown the ponderous heel section of one of the main trusses, with the trunnion bearing and the track girder with its operating rack. Fig. 3 is a view of the completed structure.

Each leaf of the bridge is operated by two 40-HP. electric motors, each pair connected to a series-parallel controller in the operator's tower at the north end of the bridge. This tower is supported by a lattice girder between the columns, B, and submarine cables laid across the channel afford the necessary connections with the motors of the south leaf of the bridge. An electric indicator with a number of lamps shows the position of each leaf during operation, the lamps being lighted and extinguished by means of specially designed contact devices connected mechanically to each leaf. The same contact devices are also connected to circuit breakers and automatically shut off the current when the bridge reaches its limit of travel in either direction. This is particularly desirable as the operator has no view of the south leaf when the bridge is raised. Each motor is provided with a magnetic brake, which is normally applied, and is only released by pressure of the operator's foot upon a switch in the floor of the tower. The centerlock is of the bar or plunger type, moving longitudinally, and is operated by a 3 HP. motor at the end of the north leaf, the position of the lock being shown by an indicator similar to those above mentioned. Signal lamps are placed at the end of each leaf as a warning to vessels and to show the position of the leaf when raised. The bridge has been in use only a short time, but tests show that each leaf required about 35 HP. for operation with the motors running in multiple, the time consumed being about 24 seconds. With the motors connected in series, the power was less than 20 HP. and the time was ab... seconds.

The substructure consists of two concre... ments of channel shape, each having a fr... and two wings. The borings for the fou... showed about 25 ft. of mud, underlai... moderately hard mixture of sand and c... each abutment a cofferdam of Wakefie... piling was built, the soft material was ... out with a clamshell bucket, and the pil... then driven and cut off. The lower part ... concrete was laid in water, the water bei... pumped out and the rest of the concr... in the dry. In the night of Dec. 9, 1904, when only the south abutment had been built, an earthquake shock caused a 3-in. crack at the intersection of the abutment and the west wing, the rear end of the wing settling about 4 ins. and also moving out about 4 ins. To determine the condition of the foundation, this end of the wing was loaded with 65 tons of steel rails, which remained in position for about a month. As no further settlement had then occurred, the crack was filled with cement grout, tie rods were put in to prevent any further movement, and the wall was then leveled up to the proper elevation and made ready for the superstructure. In the recent earthquake, the two abutments were

FIG. 1. HALF ELEVATION OF PAGE BASCULE BRIDGE AT THIRD ST., SAN FRANCISCO, CAL.

pushed forward 8 or 10 ins., raising the leaves so that their ends were 5 or 6 ft. above the horizontal and jammed together so that they could not be lowered. No electric current being available the leaves were raised by block and tackle operated by steamers, and as soon as they were released a further movement of about 1¾ ins. occurred in the abutments. The exact amount of

ILE BRIDGE.

0 to 23,000 employees with ut 16,000 or 17,000) there tal than for many months d 450 beds vacant in hos- thentic case of yellow fever uitoes are so scarce that reened houses, and discard urring personal discomfort. at he has the health situ- epidemic can arise within r can come only from the ie general health conditions e of sickness was only 20

S FOR EMPLOYEES.

is not only provided ample e, but at this time has a late 3,000 additional labor-

for a possible emergency. This means of adequately meeting the daily needs will be continued until the rainy season again provides an exhaustless supply through the use of the reservoir system.

HEALTH CONDITIONS.

Under the direction of Governor Magoon health conditions on the Isthmus are most satisfactory. Notwithstanding the fact that there are more employees and their dependents on the Isthmus than ever before (the monthly

ers. It has also provided suitable quarters for all American employees who may now be living in Commission houses, except in isolated cases where economic and other conditions may make a change undesirable.

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way, had charge of the construction. The Thomson Bridge Co., of San Francisco, had the contract for the substructure and the erection of the superstructure, the steel work for the latter being built at the Lassig (Chicago) shops of the American Bridge Co. The electrical equipment was installed by Geo. P. Nichols & Brother, of Chicago.

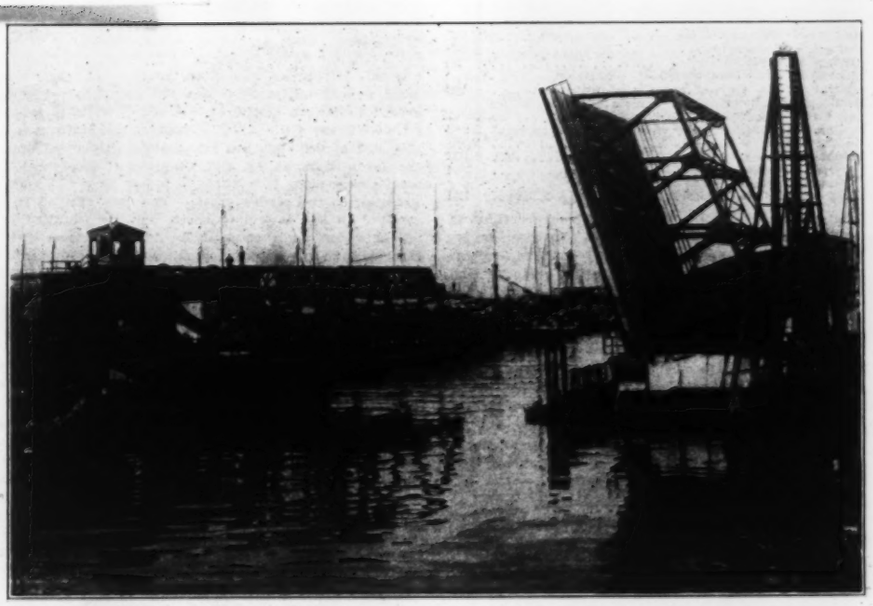

FIG. 3. THE PAGE BASCULE BRIDGE AT THIRD ST., SAN FRANCISCO, CAL.

PRESENT CONDITIONS ON THE PANAMA CANAL WORKS.*

THE WATER SUPPLY.

One of the first things brought to my attention upon arrival on the Isthmus was the condition of the water supply at Colon. Chief Engineer Stevens reported that the present dry season had extended over a longer period than any other during the past 25 years. As a result streams available for water supply were lower and the fear of a possible water famine greater than for many years. While the reservoirs supplying the districts of Panama, Empire, Gorgona, and Bas Obispo contained sufficient water for many months to come, the stock of water in the reservoir supplying the district of Colon had become reduced to 1,500,000 or 2,000,000 gallons. Therefore, as a means of impressing upon persons residing in that district the danger of extravagant use of water, Mr. Stevens equipped a water train, erected three temporary water stations in the Colon district, and began hauling into that district 250,000 gallons per day for daily consumption, holding the supply in the reservoir

*Condensed from a Special Report made by the Chairman of the Isthmian Canal Commission to the Secretary of War on April 23.

vide, and at Pedro Miguel, on the Pacific side, which are to receive the dirt trains moving down from the various levels of Culebra cut, there to be switched and forwarded over the main line of the Panama Railroad for final disposition, are well under way.

Several miles of the double tracking of the Panama Railroad main line have been laid, and the grading for more is advancing rapidly. The necessity for this double tracking, especially north and south of the two yards whence the dirt trains will come onto the Panama Railroad main line, is becoming urgent, as will be seen from the fact that recently 148 train movements were made over one section of the road in one day.

WORK IN CULEBRA CUT.

The work of putting Culebra cut in shape for the approaching wet season, as well as for the installation of the largest possible number of steam shovels on a systematic plan, has been steadily carried forward. All the barriers across the cut left by the French have been removed, and not only have tracks been laid and ballasted on each level, but for most of the way through the bottom of the canal prism a well-ballasted double-track line has been constructed. About 60,000 yds. of the dirt slide have been removed, leaving a berm 150 ft. wide back from the slope of the canal prism, so that if this slide continues to come down none of it will push over into the prism, as it has done heretofore. Following this same rule, in two or three years more the entire slide will have been removed. Clay on the top of the cut, on the other side of the prism, which can not well be handled during the wet season, has also been removed wherever there was danger of the side of the cut going far enough back to permit this clay to slide into the prism this season. This work is so well along that if the present good weather should continue two or three weeks more, Culebra cut will be in such shape as to permit of the removal of the largest quantity of material during the wet season, without danger from any of the mishaps from slides, or derailments due to bad tracks, which have heretofore been attendant upon such efforts.

Chief Engineer Stevens during the month of March, without making any special effort, but following the general policy of work herein outlined, removed 240,000 cu. yds. of material, with an average of $10^{7}/_{10}$ steam shovels working. The reports up to the 15th of this month indicate a still greater degree of efficiency in excavation. He believes that by July or August he will have forty shovels installed, and will be in a position to remove approximately 1,000,000 cu. yds. per month. The actual cost for material handled during March, figuring in contractor's expenses, was 53½ cts. a cu. yd.

MATERIALS AND SUPPLIES.

Under the direction of Mr. W. G. Tubby, head of the division of materials and supplies, appointed some five or six months ago, order and system prevail in this important work. Materials and supplies on hand have been inventoried, new storehouses constructed, lumber yards provided, and a system established whereby Mr. Tubby knows every day exactly what materials and supplies he has on the Isthmus, and where they are located. The danger of duplication of orders has been removed, and although materials and supplies have been received in larger quantities than ever before they have been handled with expedition and at greatly reduced cost.

WORKING FORCE.

The working force of the Isthmian Canal Commission as of date April 1 was distributed broadly among the different departments as follows:

Government and sanitation	2,845
Materials and supplies	1,670
Auditing and disbursing	90
Engineering and construction:	
Administration (including care of quarters)	460
Municipal engineering (in charge of construction of water supply, sewerage, roads, etc.)	3,295
Master builder (in charge of houses and quarters)	2,946
Motive power, shops, etc.	1,521
Culebra division, canal	3,103
La Boca division, canal	384
Cristobal division, canal	433
Chagres division, canal	134

The morale of the force and its efficiency continue to improve. As the employees in all the departments get more familiar with the work required of them, and as the organization becomes more settled, a corresponding increase in the effectiveness of the force follows, as is shown by increased work at a less cost than before.

CIVIL SERVICE EXAMINING BOARD ON THE ISTHMUS.

It has been decided to establish on the Isthmus a local examining board to be composed of canal officials, acting under the Civil Service Commission, for the purpose of testing the fitness for appointment to positions, subject to the Civil Service requirements, of those persons who may of their own accord appear upon the Isthmus, and who are believed to be fitted, and whose services are needed by the local officials. The eligible lists resulting from these examinations held on the Isthmus are to be separate and distinct from those resulting from examinations held in the United States.

REMOVAL OF HEADQUARTERS.

Following the policy decided on at the time of a former visit to the Isthmus, Chief Engineer Stevens has removed his headquarters from Panama to Culebra. The residence of the chief engineer and the administration office buildings have been occupied for several weeks. Some of the necessary quarters for the offices and headquarters employees are finished and occupied, and additional quarters to amply provide for the remainder will be ready for occupancy in a very short while. Meantime, some of the employees are brought from other nearby quarters on the line of the railroad. The chief engineer reports that he is delighted with the new location, and that he thinks the efficiency of the force has been increased fully 50%.

TYPE OF CANAL—DECISION URGENT.

Finally, the most important and pressing question before the Commission to-day is a decision in regard to the type of canal to be constructed. Chief Engineer Stevens pointed out to me the route of several diversion channels the construction of which should be underway, but which he can not commence until the type of canal is decided upon. We have also in mind certain other intermediate yards which we can not locate until that decision is reached. We are also holding back the improvements at La Boca (the Pacific terminus), both as to terminal yards and the extension of the steel pier, already referred to, not knowing whether or not the type decided on will cause us to abandon all these improvements. The extent and character of additional machinery to be used, as well as the extent and character of additional equipment to be purchased, are all awaiting the determination of this most vital question, and inasmuch as all this machinery and equipment must be manufactured to order in the United States, and manufacturers in almost every branch are filling their books with orders months ahead, the delay in reaching a decision as to type may mean a very serious delay in getting the necessary plant, and thus ultimately mean serious delay in the construction of the canal.

Very respectfully,

T. P. Shonts, Chairman.

THE CALIFORNIA EARTHQUAKE: MOVEMENTS ALONG THE SANTA CRUZ FAULT LINE.*

By John C. Branner, Ph. D.†

To those acquainted with the geology of the region affected by the late earthquake, it is evident that the disturbance is directly related to the geologic structure. Through the region affected there are several profound fractures that pass downward from the surface of the ground to an unknown depth in the crust of the earth. One of the most important of these fractures, or faults as the geologists call them, runs through the Santa Cruz range of mountains. Starting on the coast near Mussel Rock, a few miles south of Lake Merced, it passes through San Andreas and Crystal Springs lakes, just west of Searsville lake, through Portola Valley, over the top of Black Mountain, down Stevens Creek canyon, over the water-shed at Sycamore farm, crosses Campbell Creek, two miles southwest of Saratoga, and follows the same southeastern direction past the reservoir and so on in the direction of Chittenden on the Pajaro river.

Shortly after the earthquake I went to examine the ground in the vicinity of this old earth fracture, and found that there had been a new displacement along this line. These facts suggest that there was a readjustment of the strains and pressures that affect the rocks of the earth's crust, and that this readjustment caused the rocks to slip upon and against each other along this old line of fracture. Such a slipping would necessarily cause a jarring of the entire region along and near the fault line, and this jarring we call an earthquake. It seems somewhat remarkable at first that the area affected should extend so far up and down the coast, while it is comparatively narrow. This is because the faults through this part of the State are all approximately parallel with the Santa Clara Valley, and when one of these readjustments takes place it is likely to follow these old lines of weakness in the earth's crust. The area affected is not confined to the fault line itself, but the vibration jars all the region along and near the line of fracture.

It may be of interest to know where some of the evidences of this earth movement may be seen. In the Portola valley, six miles southwest of Palo Alto, the earthquake cracks along the old fault line may be seen at many places. Following the public road up Los Francos Creek past Burke's place and the Blue Goose saloon, about a mile southwest of the last named place, the Portola road turns square to the right. Instead of going on toward Portola one should go straight ahead and follow the road about half a mile further, where the earthquake cracks will be found crossing the road. There will be no difficulty in recognizing the place for unless it has been repaired lately one cannot ride or drive over broken roadbed. Just north of the road where these cracks occur an oak tree was broken by the violence of the shock. In the fields to the northwest and to the southeast one can see an irregular ridge of earth thrown up along the line of the fracture.

From this place one should go back half [illegible] take the road to Portola. There were at first [illegible] cracks just where the road turns to the north [illegible] Portola, but these have probably now been [illegible] rains. After passing the Portola school-ho[illegible] was thrown off its foundation, the road bends [illegible] Just here in front of a small house there [illegible] cracks across the road and extending throug[illegible] up and down the valley. The next place where [illegible] show in the road is between the Preston ho[illegible] upper end of the Searsville lake. Here a fen[illegible] in two, and a gap nearly 4 ft. wide was mad[illegible]

Further along to the northwest fences ar[illegible] and the water-pipe of the Bear Gulch Co[illegible] broken and displaced 73 ins. At one place a f[illegible] ing the fault line has been displaced as mu[illegible] This 8-ft. break in a fence shows approx[illegible] amount of the earth movement that produced [illegible] quake. Besides this lateral thrust of 8 ft. [illegible] vertical displacement amounting in some loc[illegible] ft. and more. On top of Black Mountain, on [illegible] Mill road, this fracture shows about a quarter [illegible] south of the Mountain House. At this place [illegible] that there was a lateral thrust of 3 or 4 ft., [illegible] tical movement also of about 2 ft.

Black Mountain has therefore risen about 2 ft., and it has moved 3 or 4 ft. toward the southeast; or it may be instead that the opposite side, or Castle Rock Ridge, has sunk about 2 ft. and moved 3 or 4 ft. toward the northwest. When one considers the enormous mass of rocks involved in these movements—a height of 2,700 ft.—the violence of the earthquake shock is not to be wondered at.

The geology of this entire region shows distinctly that it always has been and that it always will be one of earthquakes. I hasten to say, however, that it is absolutely impossible for any one to predict earthquakes, and it is equally impossible to prevent them. But there is no reason for alarm. The shocks here in California are generally too slight to have any importance. The earth fractures rebreak easily and the readjustments are easy. The earthquake of April 18th is probably as heavy a shock as has ever been known here. The plain practical lesson of it is that buildings should be so constructed that they will not be injured.

Some anxiety has been expressed regarding the possibility of an enormous wave from the ocean breaking on the shores of the Bay of San Francisco and overwhelming the cities around it. Such a thing is quite impossible. The narrowness of the Golden Gate makes it impossible for a tidal wave to get into the bay fast enough to overwhelm the towns.

A TIME TEST OF A GAS PRODUCER PLANT was made for the Fuel Testing Committee of the U. S. Geological Survey recently by Prof. R. H. Fernald, at St. Louis, Mo. The plant comprised a 250-HP. Taylor pressure producer, a vertical three-cylinder, 235-HP. Westinghouse gas engine, and a belt-connected 175-KW. dynamo; the output of the dynamo was wasted into a water rheostat. The coal used was screened bituminous coal from Donk Brothers Coal & Coke Co.'s Mine No. 3, near Troy, Ill.; it analyzed:

Moisture, per cent	14.68
Volatile combustible, per cent	30.98
Fixed carbon, per cent	42.93
Ash, per cent	11.41
(Sulphur, 1.33%).	
Calorific value, per lb., dry coal	12,343 b. u

The coal was broken to 3-in. size and was fed to the producer in charges of 150 lbs. Ashes were removed every 48 hrs. without interrupting the operation of the plant, the producer being run as a suction producer during the hour required for ash removal. The producer plant comprised the producer, a water-sealed dust-collector, a scrubber, and a centrifugal tar extractor, from which latter the gas went to a holder, and through a meter to the engine.

The plant ran for 24 days, and was then shut down on account of excessive deposit of tar in the water-seal valve between the dust-collector and scrubber. This latter was chargeable largely to the fact that the pipe-connections were not as short and direct as would be fitted in a commercial plant; between dust-collector and scrubber the pipe had three right-angle turns and a water-seal valve, a total length of 20 ft. of pipe instead of about 3 ft. These conditions existed because the plant is designed for general fuel-test purposes. During the run the plant separated out 14,950 lbs. tar, or 143 lbs. per ton of coal; the tar contained less than 10% water. The heat value of the gas was determined every 20 mins. throughout the run, and its composition every 2 hrs. The average calorific value was 156 h. u. per cu. ft.; the average temperature when leaving the producer was 644° F. The average composition was: Carbon dioxide 9.2%, Carbon monoxide 20.9%, Ethylene 0.4%, Methane 1.9%, Hydrogen 15.6%, Nitrogen 52%, Oxygen and Sulphuretted hydrogen zero. The engine gave no trouble at any time during the test period, and at the end of that time was found in perfect condition, requiring no cleaning. The producer plant was also found in excellent condition.

*From a paper in the "Palo Altan" of May 1.
†Professor of Geology, Stanford University.

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There has recently been issued by the New York Railroad Commission a pamphlet giving traffic statistics of the Greater New York street railway systems, surface, elevated and underground for the years 1904 and 1905. The summary at the end of this pamphlet shows that in the whole of Greater New York in 1905, the total cash fares paid was 1,171,151,698, and the total number of transfers was 271,195,524, making a total number of passenger journeys of 1,442,347,222. The total car mileage was 230,664,543. The total population of Greater New York in 1905 was 4,013,781. As the cash fares paid are all 5 cents, the total receipts of the street railway companies of Greater New York were in round numbers $58,550,000, or over $14.50 for every man, woman and child of the population. It may be said that some part of the street railway fares are paid by strangers visiting the city. This would be fully offset, however, by the fact that a large amount of expenditures for local passenger traffic on the ferries and steam railway companies operating within the city limits is not included in the above total; hence the average per capita contribution of the permanent residents of the city to the local passenger transportation lines must be fully as great a sum as that named above.

It is of interest to note, from the above figures, that the average resident of Greater New York takes 290 street car rides during a year. Also that the average cash fares and transfers received by the conductor per car mile are 6.27. The average number of passengers per car cannot be stated, because the length of the average passenger journey is indeterminable. As the great bulk of the traffic consists of travel between homes and places of work, and New York is notable for the great distance between its business districts and its residence districts, the average passenger journey must be several miles in length; and observation indicates that the average number of passengers in a car is, without doubt, in excess of its seating facilities.

The low water consumption of many British municipalities is a never-ending cause of wonderment to water-works authorities in the United States. A striking illustration is afforded by recent events at Leicester, a remarkably well managed borough supplying water to about 268,000 people, including some districts outside its corporate limits. Here the daily consumption has been reduced quite recently from 23 to 16 U. S. gallons per capita. It appears that this has been partly due to a shortage of water, but in general it is in line with the set policy of the local authorities. That there are good reasons for striving to keep down the water consumption and waste at Leicester will be apparent when we state that the supply is impounded from numerous surface sources, filtered and pumped, and that the sewage of the borough is pumped 180 ft. to a sewage farm. This farm consists of a dense clay, with so thin a layer of top soil as to make it necessary to pick up the effluent from the applied sewage and again distribute it over the land. The volume of sewage has overtaxed the farm for some years, and only by dint of hard, intelligently directed labor, and much sacrifice of crops, has a serious nuisance been avoided. With such conditions of water supply and sewage disposal it is no wonder that water waste prevention has been highly developed at Leicester. Notwithstanding the success that has attended these efforts the growing population and a deficiency of 4 ins. in the rainfall of 1905 resulted in a reduction of storage capacity, by the end of the year, to some 33 days' supply, and that in the face of shutting off the supply for ten hours a day. Mr. Frederick Griffith, M. Inst. C. E., is Engineer and Manager of the Leicester water-works. Mr. E. G. Mawbey, M. Inst. C. E., is borough surveyor, and has charge of the sewage works. American cities may well be thankful that they are seldom confronted by anything like such a need for conserving water as exists at Leicester, but at the same time it should be remembered that with our increases in both urban and rural population, and our consequent rapid decreases, relatively, in naturally pure water serious problems have already presented themselves here and more are rapidly coming to view. Daily per capita consumptions of 100 gallons are generally looked upon as models in America and not a few large communities tolerate, while some boast of, consumption (and waste; mostly waste) running from 150 to 300 gallons per head per day. The fact that a goodly number of American cities get on comfortably with from 60 to 35 gallons a day, with little to account for it save prudent measures against waste, clearly shows that it is wholly practicable to approach somewhat near British figures for water consumption. We do not, however, set the lowest of the British, or even of the American, figures as a universal ideal. But we do plead for the suppression of absolute waste, which in many cities is very large, and for a more equitable division of the cost of the public water supply than prevails where waste goes unchecked.

A lime mortar which will develop an ultimate strength of 75 to 150 lbs. per sq. in. and is made from inexpensive materials is described elsewhere in this issue, and would appear to have many important industrial applications. It is unsuited for use in bulk like concrete, as it requires exposure to the carbonic acid of the air to develop its hardness, but it would appear to promise much as a material for giving a satisfactory surface finish to masonry or other work. While complete experiments with the material are still to be made, it appears likely that it can be given any desired color, whereas with Portland cement, little can be done in the way of coloring without danger of disintegration.

A novel plan for digging the Culebra cut is described elsewhere in this issue. While we have deemed it worth while to give it space as an interesting study of a huge problem in engineering, we are obliged to confess ourselves wholly unconvinced that the system described could compare in economy, rapidity of work and *reliability* with the simple, straightforward plan of loading directly into cars with steam shovels.

Mr. Hill would build a three-track tunnel 8 to 10 miles long, 44 vertical shafts 50 to 150 ft. deep, 44 huge traveling cableways big enough to span the completed Culebra cut, and a complete outfit of tracks, dump cars and tipple for each shaft. All this equipment is to be installed and operated for what? Merely to save a certain amount of work in shifting the through tracks in the cut while excavation is in progress. It is to be noted that Mr. Hill does not wholly avoid track shifting even by his complicated plant; for after he has about a third of the material excavated he has to lay new lines of track through the cut.

The essential fallacy at the bottom of Mr. Hill's scheme is a great over-estimate of the cost and difficulty of operating the various tracks in the cut while excavation is going on. Of course some intelligent planning will be required; but we see nothing involving any enormous cost or any serious difficulty. Mr. Hill's own plan affords only one outgoing track for loaded trains and one returning track for empties. The Culebra cut is wide enough to afford space for a four-track or six-track railway and still leave abundant room for shovels to operate without disturbing these permanent tracks except at very long intervals.

We might criticise his proposal to load trains in an 8-mile tunnel where pieces of rock falling down the shafts would be frequently falling over onto the running tracks resulting in derailment of trains and consequent blockade of the tracks and of the entire work of excavation on the whole Culebra cut. We might suggest that experience in the New York Rapid Transit tunnel in summer indicates that such a tunnel as Mr. Hill proposes, in the Panama climate, would have a temperature beyond human endurance. It does not seem necessary, however, to criticise Mr. Hill's plan in detail.

RECORDS OF DATUM PLANES.

At the annual meeting of the Canadian Society of Civil Engineers, three months ago, a meritorious "record" paper was presented, in which are given the results of a research by Mr. W. B. Dawson into the comparative levels of the datum planes employed in the surveys for the important engineering works of the Canadian Pacific Coast region. The paper revealed a surprising multiplicity of these reference planes. Each new undertaking, public or private, seems to have erected its own datum plane, irrespective of other surveys. The result naturally was a confusion of records, which in time would surely have produced costly errors. It happens that this condition of things is largely chargeable to the peculiar tidal conditions of the west coast, which makes it an extremely delicate and uncertain matter to establish the Mean Sea Level; long-continued observation is now in progress to determine this important elevation. Of course most of the works done in or near a seaport have a more or less close relation to sea level, and therefore naturally take their reference plane at either mean sea level, mean low tide or mean high tide. The differences in guessing at these levels amply account for the differences in the datum planes recorded by Mr. Dawson.

Similar conditions are very common, probably all but universal. The Municipal Engineers of the city of New York, a young but very active local society, has for some time past had a committee at work investigating the various datum planes used by public authorities and in various large works in New York City. The committee recently rendered its report, in which it describes very fully the history of the principal datum planes used by public authorities in New York City. The actual relative elevations of these datum planes are summarized in a table which the society has printed separately on a card as a convenient desk or pocket record of datum planes. Rearranging this table, and adding some of the information given in the body of the report, yields the following:

DATUM PLANES OF NEW YORK CITY.

From Report of Committee on Datum Planes of Municipal Engineers of the City of New York, 1906.

Date of origin.	Name of Datum, Authorities using it, etc.	Elevation referred to Sandy Hook M. S. L.
1890	*Richmond High Water Datum.* Is about 1 ft. above true H. W. at Stapleton, S. I. Used by: All public authorities in Richmond Borough except Dock Dept.	+ 3.15

abt. 1840	***Public Works Datum.*** Probably derived from M. H. W. at Bellevue Hospital, and now within one or two tenths of that level. Fixed by BM. in water table of City Hall; Elevation +42.21 Public Works Datum. Used by: Highways, Manhattan Bor. Sewers, Manhattan Bor. Water, Manhattan Bor. All offices of Bronx Bor. All offices of Queens Bor. (originally, but Queens BM.'s now give a datum at +2.75 S. H. M. S. L.). Highways, Brooklyn Bor. (originally, but BM.'s now give a datum at +2.80 S. H. M. S. L.). Rapid Transit Railroad Commissioners (originally, but R. T. benchmarks now give a datum at +2.72 S. H. M. S. L.). New York Central & Hudson River R. R. in boroughs of Manhattan and Bronx. Pennsylvania, New York & Long Island R. R. in boroughs of Manhattan and Queens (originally, but their benchmarks now give a datum at +2.66).	+2.67
1856	***Navy Yard Datum.*** Artificial; BM. on S. W. corner of coping of Dry Dock No. 1 was arbitrarily taken as + 5.0, but now is about + 4.4 M. H. W. at the Navy Yard. Used by: Sewers, Brooklyn Bor. Water, Brooklyn Bor. Department of Bridges. Long Island R. R. Atlantic Ave. Improvement (originally, but their benchmarks now give a datum at +1.62 S. H. M. S. L.).	+1.72
1881	***Sandy Hook Mean Sea Level. U. S. Coast & Geodetic Survey Datum.*** The apparent elevations of U. S. C. & G. Survey before 1898 were 0.11 ft. less than present, due to error in benchmark at Raritan River. Hence "Old U. S. C. & G. S. Datum" = +0.11. Used by: Board of Additional Water Supply.	Zero
abt. 1840	***Croton Aqueduct Datum.*** Used by: Old Croton aqueduct. New Croton aqueduct. Aqueduct reservoirs in New York City and elsewhere.	—0.94
1898	***Dock Department Datum.*** M. L. W. at the Battery as determined by automatic tide-gage records 1886-1898. Used by: Department of Docks & Ferries.	—2.09
1886	***Old Dock Department Datum.*** Based on short series of tide-gage records in 1886, giving an erroneous elevation for M. L. W. at the Battery.	—2.33

This list records six different datum planes in actual present use, with a difference between lowest and highest of nearly 5¼ ft. Analyzing the list, we find that 6 different datum planes are in use by regular departments or bureaus of the government of New York City, 3 different planes are in use by special boards in charge of public work, and 2 different planes by private authorities engaged in large semi-public improvements. Not all of the engineering offices of the city government are represented, only two special boards or commissions and only two of the many large private and semi-public undertakings in New York City are listed.

There is, at bottom, nothing surprising in the diversity of reference planes in New York City. The building up of this city from its component municipalities and towns accounts for a large part of the table. Another part finds its explanation in the fact that there exists no general survey of the city, and but a very insufficient number of station and bench-mark monuments, so that each new public bureau or board found it the shortest plan to establish its own basis for levels. Moreover, the elevation of mean water level in New York harbor has not been absolutely unchanging, though the movement has been very small; and quite large changes have taken place in the height of tidal rise and fall, thereby materially shifting the elevation of M. L. W. and M. H. W.

It will occur to every one looking at this list, that there is not the slightest present need for such a multiplicity of datum planes. Probably none of the offices above recorded would find any inconvenience in working with a datum common to all, say Sandy Hook Mean Sea Level, and each one of them would gain the very great advantage of being able to refer to the benchmark or levels of any other. All the various offices which work within a given borough, federal, municipal, special and private, come into frequent contact in their surveys, and generally this contact is such as to require mutual interchange of levels. The Department of Docks & Ferries and the Manhattan Bureau of Sewers use datum planes which have a rational relation to the work of the respective offices, and it might be concluded that they would find inconvenience in using a standard datum. But in regard to the latter bureau, at least, this conclusion is invalidated by the fact that the Bureaus of Sewers of Brooklyn, Queens and Richmond Boroughs are not using a datum different from that used for other public work in those sections of the city. And in the case of the Department of Docks & Ferries, careful reflection fails to reveal any strong reason to suppose that the department is necessarily tied to a low-water datum. We understand that a strong movement is under way, as a result of the findings of the Municipal Engineers' committee, to unify the measurement of elevations in the various engineering offices of New York City by basing them upon a single standard datum plane.

Multiplicity of datum planes, similar to that recorded for New York City, exists probably in every city or region where much survey work under various authorities is being done. The bad thing about the matter is not so much the diversity of datum planes in itself as the absence of any definite knowledge or record of the relation between these planes. Unless a record of levels is permanently tied to other surveys of elevation, either by referring to a common datum plane or at least by tying in to a permanent universally recognized bench, the value of those levels may partially or wholly disappear in a very few years. The difficulties encountered by Mr. Dawson in identifying the datum planes used for various past surveys in Victoria and Vancouver, B. C., afford a good illustration of this; in one case, if we remember correctly, only a chance note on a single copy of a harbor map was the means of his determining the datum plane of a considerable number of early surveys. It is desirable from every point of view that such conditions should be avoided. In every important center of surveys, a record of commonly-used datum planes, and of elevations of important benches, should be prepared and put on file by some central authority. Federal offices, such as the district offices of the River and Harbor Works and offices of Federal surveys, are excellent authorities for such record, and we believe have in some instances already given careful attention to records of this class. For the many places where no such means of survey and record exist, City Engineers' offices and local engineers' societies can perform valuable public service by preparing and filing such records.

LETTERS TO THE EDITOR

A Correct Map of the Burned Area in San Francisco.

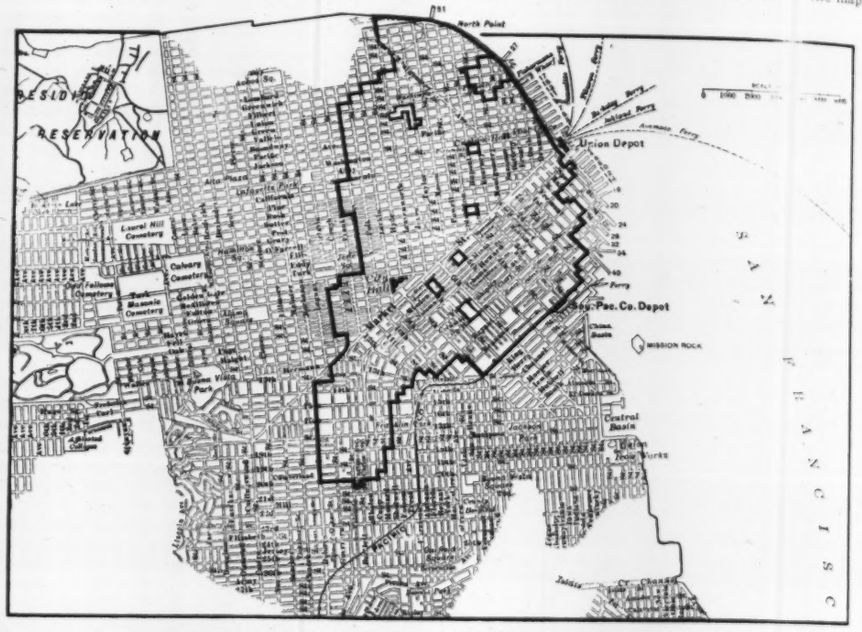
Sir: Inclosed find map showing the area burned over by the fire. This is copied from a map by City Engineer Thos. P. Woodward.

Yours truly,

Harris D. [illegible],
Asst. Eng. Dept. of Public Works.

1718 Pine St., San Francisco, Cal., May 7, 1906.

[While the boundaries of the burned district do not vary greatly from those shown on the map



A CORRECT MAP OF THE BURNED DISTRICT IN SAN FRANCISCO.

in our issue of April 26, we have replotted that map from the one given by our correspondent, and present it here as a matter of accurate record. —Ed.]

Fire Protection in Earthquake Countries.

Sir: Some one has suggested stacks of light, sheet-metal pipes, in 12-ft. lengths, kept on hand in sheds, and pumping engines near the water supply. This does not appear to me to be very practical, nor good.

But suppose dependence be placed on fire-boats, which an earthquake is not apt to harm, and on several such in each city, so that some at least may survive.

Then lay the wrought-metal force-mains in the ground, using an approved form of ball-and-socket joint, and laying the pipe in a zig-zag or wavy line, so as better to allow for wave motion in the ground; or, what is the same thing, allowing for extra length between two original given points. Such a pipe, thus laid, is much less likely to be broken by an earthquake than a pipe with rigid joints laid in a straight line. Hydrants likewise to be connected to the main by a ball-and-socket joint.

Whatever of sole and original invention there may be about all of this is hereby dedicated to the public, especially to those inhabiting countries subject to earthquakes.

Clemens Herschel,
Hydraulic Engineer.

2 Wall St., New York, N. Y., May 7, 1906.

Is Any Allowance for Impact Needed in Solid Floor Railway Bridges with a Deep Layer of Ballast?

Sir: A railway yard is to be raised several feet and carried across a street on a steel span. This span is to carry between 2 and 3 ft. of ballast—to be so covered, in fact, that it will in no way interfere with the laying of the necessary tracks and switches. The question arises in designing as to whether the impact of the moving load should be computed as usual; whether the thick layer of ballast would deaden it to such an extent as to render it negligible; or whether a middle course should be taken and a coefficient, smaller than usual, be chosen. A discussion of this subject should prove valuable, as

such cases are not rare, and impact is an important item in such designing.

Yours sincerely, L. F. V.

City of Mexico, May 4, 1906.

[We see no need of impact allowance under the conditions named, but shall be pleased to hear from any engineers who may have arguments in its favor.—Ed.]

Protective Coatings and the Life of Riveted Steel Pipe.

Sir: In Mr. Mayer's discussion of the question of protective coatings for steel water pipes in the Engineering News of April 26 he has brought together a good deal of valuable and interesting information.

It is well known that the life of cast-iron pipe varies with the conditions under which it is placed and in the case of a pipe of thin steel plate this variation will evidently be much more marked, so that any fixed term of life should be accepted only after a full knowledge of these conditions. In the first place the character of the metal itself, chemically and physically, will affect to a considerable degree its resistance to corrosion. A homogeneous metal, it is understood, will deteriorate less rapidly than one in which the impuritics are found in laminations caused by the rolling of the metal in its manufacture. The effect of hard water in preventing tuberculation and the opposite effect of a soft water are well known. Surface waters sometimes contain vegetable acids and artesian waters free carbonic acid which promote corrosion on the interior surface.

In many situations corrosion on the outside is more to be feared than on the inside. In 1901 the city of Atlantic City laid a 30-in. riveted steel main from the pumping station to the city, a distance of some five miles, about four of which lies across a salt marsh. The sections were dipped in a mineral rubber bath and then wrapped with 10-oz. burlap which was brushed down on the hot coating before shipment, and it is understood that particular care was taken to recoat those portions where the coating was injured in transportation or in laying before refilling. Most of the pipe was laid in a shallow trench and so would be exposed on top but for a covering of thick sods which were cut from the adjacent meadow.*

In February, 1905, the inspector discovered a leak caused by corrosion, and by the first of January 22 of these had developed and been temporarily stopped with wooden plugs.

Now here is an instance where corrosion through ⅜-in. of steel has been from the *outside* and in spite of more than ordinary care in coating this has occurred within four years.

A singular fact noted was that all but one or two of these holes, which were from 1/16 to about ⅛-in. in diameter, occurred in a section of pipe less than one mile long, indicating, possibly, some local cause. Examination of the interior at one of the manholes after draining a section of the main showed a few blisters in the coating, but no appreciable corrosion of the metal. In general, where the coating was torn from the outer surface, the metal was found clean and free from rust; so that where the leaks have developed I think there must have been some slight defect, possibly only a pin hole, in the mineral rubber coating.

As the entire pipe line cost nearly $200,000 and is the main reliance of the city for the conveyance of its water supply it was proposed coating the steel with reinforced concrete, which, it was thought, would protect the exterior surface from the corrosive action of the salt water and the vegetable acids in the meadow mud and at the same time add somewhat to its strength. As funds for the entire work were not available, however, a contract was let covering those parts where leaks had been observed to C. W. Snyder & Co., of Atlantic City, who has done the work under the direction of Mr. Lincoln Van Glider, my successor as engineer of the water department. The protective coating is 3¼ ins., and in it is embedded Clinton electrically welded fabric.

As mentioned by Mr. Mayer, another agent that may affect the life of such a main is electrolysis. The Atlantic City main is known to return a considerable current from trolley tracks in the city to the power station located on the mainland, amounting last July to some 30 amperes constant flow. This passes from the main to a trolley track and local water main near the pumping station and is carried thence to the power station.

From the foregoing considerations it will be granted that it is not safe to assume an arbitrary fixed rate of depreciation for a riveted steel pipe, but that this depends on several important modifying factors.

Yours truly, Kenneth Allen.

Ingram Building, Baltimore, Md., May 2, 1906.

*The work was done by the T. A. Gillespie Co., under Mr. W. C. Hawley, M. Am. Soc. C. E., who was at that time superintendent of the water department. It should be said here that with the endorsement of Mr. Emil Kuichling Consulting Engineer, a wood stave pipe was recommended for this work and this would undoubtedly have proved much more serviceable, but this plan was not approved by the city council.

Progress of Excavation on the Deepest Part of the Culebra Cut.

Sir: The enclosed sketch represents the greatest cross-section of the Culebra cut. It was taken by me from the working drawings at the company's office when I was Chief Engineer for the Dutch contractors, in 1885, now more than twenty years ago, and used by me as part of an illustrated article that I wrote for Engineering News June 16, 1888. The hatched area shows about what amount of excavation had been done at that time. It would be very interesting to me, and I am sure it would be to others, if some one who has the notes, or perhaps some engineer now at Culebra, would sketch in the profile of the ground at this summit station, thus giving

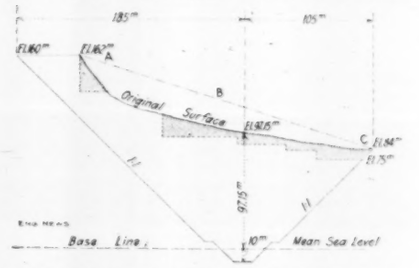


Fig. 1. Cross-Section of Culebra Cut at Its Deepest Point, Station Kilometer 54.8, Taken in 1885.

us an idea of the present cross-section and convince us as to how much excavation has really been done at that point.

There are many people who think, and others who would have us think, that the line A, B, C represents the original surface. This, however, is not true, and the 145 ft. which is claimed to have been dug should not be measured from that imaginary line.

I am sorry that more levels were not given on the cross-section, but I copied it just as it was.

To get a fair idea of the task of piercing the Isthmus, one has but to stand at that highest slope stake, almost five hundred feet above sea level, and look across to the opposite slope, eight hundred and seventy-five feet away, and then look far off towards the Atlantic Ocean and then towards the Pacific—especially after having lived there through one rainy season and to have seen how

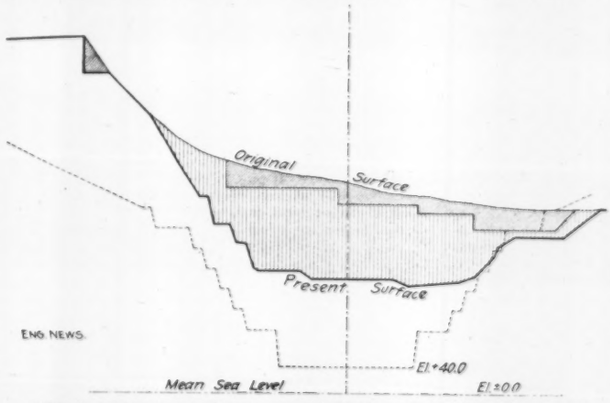


FIG. 2. CROSS-SECTION OF CULEBRA CUT AT STATION 54.8, APRIL 16, 1906.

(Dotted lines show section of completed canal for 85-ft. summit level. Diagonal shading is area excavated in 1885. Vertical shading shows area excavated since.)

long it takes to get into condition after the mud dries up so that it can be handled, to realize the immensity of the undertaking.

This great cut, coupled with the many difficulties to be overcome in connection with the Chagres River, and the years that are rolling by, tells us, who have lived in the tropics on public works, only too plainly what a gigantic struggle is now well begun between that innocent looking stream and the United States Treasury.

When I remember that the Dutch contractors received $1.50 per cu. yd. for excavation, and that the Government engineers now expect to do the same work for 70 cts. or less per cubic yard, it forces one to realize what improvements have been made in excavating machinery. For although the Dutch contractors were a most energetic set of men they were glad to be released from their contract. Very truly yours,

F. A. Snow.

161 Devonshire St., Boston, April 2, 1906.

[We have delayed publication of the above letter until we could receive the suggested additional data. Through the courtesy of Chief Engineer John F. Stevens we have been furnished with a blue print, dated April 16, showing the present cross-section of the Culebra cut at Kilometer 54.8, and have reproduced it here as Fig. 2. We have plotted thereon the section as it stood in 1885, taken from Mr. Snow's profile and also in dotted lines the cross-section of the completed channel for an 85-ft. summit level as recommended by the Isthmian Canal Commission.—Ed.]

The Bearing Power of Piles Driven with a Steam Hammer.

Sir: Anent the Engineering News formula for the bearing power of piles to which reference is again made in the issue of May 3, 1906, I beg to inquire if this formula is of equal value and applicability when applied to a steam hammer such as "The Warrington" made by the Vulcan Iron Works of Chicago, which has a rapid stroke of 30 ins. to 42 ins.

Very respectfully,

A. H. Weber,
U. S. Assistant Engineer.

Colorado Building, Washington, D. C., May 5, 1906.

[If our correspondent will refer to Engineering News of Nov. 17, 1892, he will find an extended discussion (by the late A. M. Wellington) of formulas for the bearing power of piles driven by different methods. In that article rules were given for computing the bearing power of piles driven by various methods. For the steam pile driver Mr. Wellington proposed the following:

$$\text{Safe Load} = \frac{2\,W\,h}{s + 0.1}$$

In which W = weight of hammer,
h = height of fall,
s = average penetration in inches for several blows. We quote from the above cited editorial Mr. Wellington's remarks on this penetration as follows:

12. As to s: The proper value can only be determined by taking the mean of the sets for a number of blows, nor then unless:

(a) The penetration has been at a reasonably uniform or uniformly decreasing rate, and

(b) There is reasonable assurance that the penetration would continue uniform if driven several feet further (which may be known from test piles driven to an extra depth or from general knowledge or evidence as to the nature of the soil, as that it is all sand, gravel or alluvial deposit). Also

(c) The head of the pile must be in good condition as per par. 11; and also:

(d) The penetration must be at a reasonably quick as well as uniform rate, not less than ¼-in. for a 3,000-lb. hammer falling 50 ft. Any smaller penetrations under such a blow should be assumed to be due to mashing of the point and neglected, and any penetration of less than ½-in. is to be looked on with grave suspicion, and disregarded unless it has been uniform for many blows. With soft wood piles any penetrations of less than 1 in. under such a blow is likely to involve destructive strains within the pile, and hence should be disregarded in computing bearing power.

In Engineering News of April 5, 1894 was given an extended test of the bearing power of piles driven by both drop and steam hammers, which appeared to sustain the substantial accuracy of the above formula.—Ed.]

Proposed Earthquake-Resisting Type of Building Construction for San Francisco.

Sir: The great catastrophe at San Francisco and elsewhere throughout California has very naturally prompted the question whether or not it is possible in the future to prevent such great loss of life and property. We have read during the past few days many answers to this inquiry.

Before detailed and scientific information regarding the facts of the earthquake is received it is somewhat premature to express final opinions; but enough evidence of a general nature has come to hand to warrant the conclusion that while it may not be within the bounds of human effort to entirely prevent, it is quite possible to minimize the loss of life and property, should such

another visitation occur, if proper precautions are taken in the rebuilding of San Francisco. We therefore take the liberty of expressing our views on the subject, believing that a thorough and free discussion among engineers will be of benefit to the community at large.

It is an engineering possibility to design a structure, such as a ship, for instance, that will withstand almost any kind of strain, and adapt itself to all manner of conditions. It is also an engineering possibility to design a steel frame building so that it will stand a great deal of shock and inequality of settlement in the foundations, due to a distortion of the earth supporting it. The proper adaptation of such structures to the needs of those occupying them is a modifying condition, which, together with the architectural requirements, has to be considered in this problem. Broadly speaking, it is a question of applying sound engineering principles to the problem in hand.

Buildings for business and office purposes should not be high in the New York sense; it might be well to limit the height to 100 ft. There should be ample lot area, and the buildings should be cubical in shape if possible, so that in the shape itself there would be an element of stability.

These buildings should be entirely of steel skeleton construction, in which the walls are supported at every floor. Columns should be as far apart as possible, and the connections and joints of columns, beams and girders should be so designed that while there would be enough stiffness to withstand wind pressure, an easy matter to take care of in buildings of the height and shape recommended above, there would be sufficient flexibility to allow the steel frame to adjust itself to unequal settlement of foundations within reasonable limits, without permanently injuring the steel skeleton.

Some have advocated the use of a steel frame as rigid as possible. This we believe to be a mistake, because such a frame could be very seriously injured, in fact beyond the possibility of repair, if the inequality of the settlement in the foundations were sufficiently great.

Foundations should be carried down, if possible, to solid rock or hard-pan, and spread over steel grillage, and all these foundations should be tied together with steel girders.

Floor construction should consist entirely of steel beams and girders, supported on steel columns, and the joist beams should not be spaced over 6 ft. apart. Floors should be of reinforced cinder concrete, the reinforcing consisting of tie rods spaced about 6 ins. apart and securely fastened to the beams, and a wire mesh should also be used in the floor slab, as an additional security to hold the concrete in position in case of fracture.

The walls should be as thin as possible consistent with climatic conditions and the requirements of fire protection, and might better be made hollow with an air space. The best material for this purpose we believe to be reinforced concrete, with a framework of structural steel around all openings, and made practically in the same way as the floor construction described above, the important thing being that there should be plenty of steel reinforcement, and that it should be securely fastened to the steel framework of the building. If brick or cement blocks are to be used the walls should not be more than 12 ins. thick, and should be well anchored to steel uprights spaced not more than 6 ft. apart, these uprights being attached to the steel frame of the building. It is needless to add that this work should be laid up only in Portland cement mortar, and that the workmanship should be of the highest order. Floors and walls built as described above might in case of an earthquake crack or warp, but it is difficult to imagine them collapsing.

Cornices and projections should not be allowed of masonry. If they are necessary from an architectural standpoint they should have a steel skeleton thoroughly well attached to the steel frame of the building, forming a support for the reinforced cement or copper covering.

The water and gas pipes and electric wires should have special ducts, and the practice of carrying these next the columns, and surrounded by their fireproof covering, cannot be too strongly condemned. There should be expansion joints in the water and gas pipes, to avoid breaking in case of settlement of building.

To fully protect a steel frame building against fire there is probably nothing better than concrete. All the columns, beams and girders in such a structure should be thoroughly encased in Portland cement concrete.

In the design of the new Lackawanna Terminal now being erected at Hoboken, N. J., Mr. Kenneth M. Murchison, Architect, the conditions to be considered were somewhat similar to those which might be expected in an earthquake, but to a less degree. Both unequal settlement of the foundations and shock had to be provided for, the building resting altogether on friction piles 80 to 90 ft. long. It was so designed that unequal settlement would not injure the steel frame, and the walls were made of reinforced concrete as described above, for the same reason, and to withstand the shock due to a blow from a heavy ferry boat.

The use of monolithic reinforced concrete construction in place of the steel skeleton for the rebuilding of San Francisco, or for use in any earthquake district, does not appeal to us on account of its lack of flexibility. In the event of unequal settlement, numerous cracks would undoubtedly develop where columns and girders connect, and the repairing of such a building would be an exceedingly expensive and difficult matter.

Reinforced concrete construction has its uses; but in the present evolutionary stage of its development there is a strong tendency to employ it under improper conditions. Any condition which would crack a monolithic reinforced concrete building or cause the steel reinforcing rods to separate from the concrete should condemn its use for that particular case. For this reason it is not recommended for railroad bridges, nor does it appeal to one's judgment to use it for the frames of high buildings in localities subject to earthquakes.

Steel encased in cement is the best material known with which to construct the frames of high buildings, but to meet the complicated conditions such as the ideal building for San Francisco would require, the designs and details must be carefully worked out.

Yours truly,

Weiskopf & Stern, Consulting Engineers.

68 William St., New York, N. Y., May 9, 1906.

The Design of Dams and Embankments on Permeable Foundations with Special Reference to the Gatun Dam.

Sir: Some reflections are induced on the subject of foundations for earth dams, by reading the very interesting discussion of the Gatun dam problem in Engineering News of March 29, as embodied in the testimony before the senate committee by Prof. Wm. H. Burr and Mr. Frederic P. Stearns.

From the various discussions of the Gatun dam that have appeared in print the situation appears to be this: It is proposed to build a very large earth dam across the channel of the Chagres River at Gatun, with a base width of about half a mile. While no precise statement of the form of cross-section of the proposed dam has come under the eyes of the writer, it is inferred from discussions of the dam that the height is to be about 100 ft., with a crown width of 100 ft., and combined side slopes of 25 to 1, the upstream slope to be perhaps 5 to 1 and the downstream slope 20 to 1.

The channel of the river is filled, beneath the base plane of the proposed dam, with fluvial deposits of a more or less permeable structure to a depth of more than 200 ft., with a suggestion of an older gravel deposit below that, in the deeper parts of the channel.

Mr. Stearns discards the idea that it is feasible to treat this foundation in the customary way, by interposing a structure of impermeable material down to "bed rock," on account of the extraordinary depth to be penetrated and other difficulties incidental to the situation.

He appears, however, to have demonstrated with reasonable conclusiveness, that such a mode of treatment is not necessary, but that with a base width of 2,625 ft. for the dam, under a hydrostatic pressure due to a head of 85 ft. of water against the dam, the medium to be traversed by seep water is so extended that the flow must be entirely suppressed, or reduced to a negligible quantity.

Similar conditions that obtain along the lower Mississippi River in relation to levee building present the same problem on a diminished scale. In the Yazoo basin particularly, the problem is accentuated by the general prevalence of heavy sand deposits underlying the top stratum of "buckshot" clay, the latter being usually fr... ft. deep. These sand strata are of variable, and i... localities unknown depths, but certainly deep ... defy all practicable devices to cut off the ... underground flow by any of the usual method...

This sand, which is sometimes intermixed wit... is for the most part not of "alluvial" character... longs to the estuarian deposits known to geolog... "Port Hudson" formation.

It is a simple enough problem from an engineer... of view, to erect a continuous bank of earth of ... height and dimensions to resist any given ... But the question of foundation insecurity and ... therefor is one of considerable complexity. A... of the piece-meal manner in which the existing ... levees on the Mississippi River has been ... through a course of years by successive enlarg... the embankments, the prevalence of borrow ... cavations behind the levees is quite general, and ... a fruitful source of leakage from underground ... neath the levee.

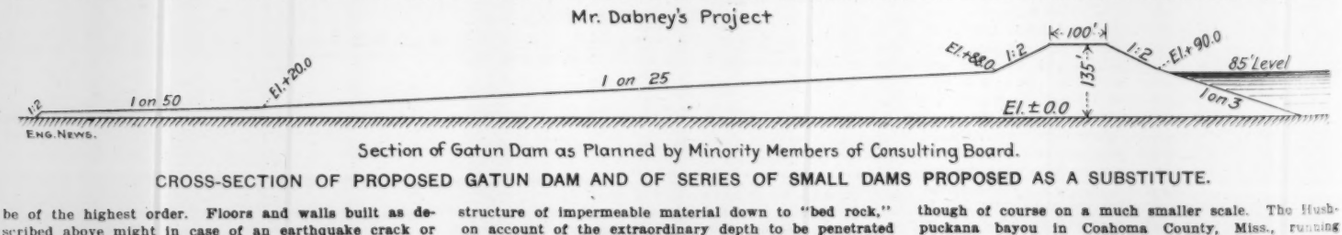
This not unfrequently assumes an alarming as... flow being in eruptive form in copious volume, an... ing up large quantities of sand, etc., with corre... displacement below. In some cases in levee hist... eruptive leakage has resulted in a "blow out," ... collapse of the levee, followed by great disaster. The fighting of this danger when developed suddenly und... critical conditions is among the common experiences ... levee engineers.

The readiest and usual method of combating thi... trouble is by creating a pool of dead water over the crater of the "boil." This is accomplished by building a ... of earth-filled rock around the place of eruption, or sometimes an earth dam between two rows of hand-driven sheet piles. The functions of this ponded water are twofold. First, the obvious result of reducing the velocity head and so diminishing the force of the flow; and second, the cushion of dead water over the aperture of discharge localizes the deposit of the solid material brought up, which after a time by continually dropping back into the crater chokes it up and stops the flow or reduces it still further.

This mode of treating foundation weakness under the levees has led to the development of a system of permanent works on a more extended scale in which the same principle is invoked, to afford assured security wherever such weakness may have developed or is suspected. The method used is to erect a permanent "sub-levee" behind the main levee, usually consisting of two wings, connected at one end with the levee banquette, and extending at right angles across the borrow pit, the other ends being connected by a "curtain" located back of the pits. The expanse thus inclosed may cover an area of one acre, or of eight or ten acres, according to the extensiveness of the region of instability. The water is ponded to a depth of 6 ft. or more over the treacherous area. In the larger basins it is found expedient to hasten the process of filling them by the use of 8-in. siphons over the levee.

In a few cases there are series of sub-levees and basins, a second one behind the first at a lower elevation. The sub-levees are provided with plank spillways over the crest, and a bottom pipe drain controlled by a valve for emptying the basin after the flood has subsided.

One example of this treatment in the writer's experience has features which bear a rather direct analogy in some respects to the conditions presented at Gatun.



Section of Gatun Dam as Planned by Minority Members of Consulting Board.

CROSS-SECTION OF PROPOSED GATUN DAM AND OF SERIES OF SMALL DAMS PROPOSED AS A SUBSTITUTE.

But a sand deposit of extraordinary depth underlies the surface material along the upper though of course on a much smaller scale. The Hushpuckana bayou in Coahoma County, Miss., running from the vicinity of the river bank southeastward (all such bayous are distributaries), has incised a channel through the "river bottom" formation which is 70 ft. deep and has a bank width of 600 to 800 ft. A half mile from the river bank this channel is traversed by the line of levee. The levee across the channel has side slopes of 4 to 1, a crown width of 10 ft., and a banquette on the land side with a crown width of 40 ft. and crown slope of 20 to 1. Banquette grade is 8 ft. below levee grade. This structure has proved to be entirely adequate to resist the pressure of floods, and no foundation weakness has developed in the bed of the channel, which is composed of tough clay.

bank of the bayou channel. This sand becomes loaded with water during every flood stage in the Mississippi River, and discharges under the bank of the bayou into the channel below the levee, creating such instability of the bank as to menace the integrity of the levee. To correct this evil a sub-levee was built across the channel 300 ft. below the main levee, with a grade elevation which pooled the water about 10 ft. over the defective zone along the bank. This proved entirely effective in stopping any further movement. But similar movements developed in the bayou bank below the sub-levee, which threatened to involve that also. So a second sub-levee was built a quarter of a mile below the first. The grade of sub-levee No. 1 was raised so as to increase the depth of the upper basin by 8 ft. additional, while the water in the lower basin is 10 or 11 ft. below that in the upper. This arrangement has proved quite effective in giving security to the levee.

The principle of combating foundation weakness by dividing the hydrostatic pressure has come to be regarded as indispensable in the writer's experience as a levee engineer, and has been extensively resorted to during the past dozen years. Now in theory at least it would appear that this principle might be applied in the case of the Gatun dam problem with economy in cost and added security to the dam.

If the Gatun dam is to be simply a convenient spoil bank for the disposal of wasted material, this argument cannot apply to it. But if, as is probable, the structure is to cost so much per cubic yard, then a reduction of the cubic yards must reduce the cost.

It is not pretended that the principle of subdividing the hydrostatic pressure is practically applicable or expedient in the Gatun situation, the writer's knowledge of specific conditions there being too limited for such assumption. But the suggestion is thrown out for the consideration of engineers in a general way, who may find its application convenient in other situations.

If, however, any doubt should exist on either of these points, it is certain that a solid prism of water 50 ft. deep occupying the channel for a distance of say half a mile below the dam, and other pools of diminishing depth extending for an indefinite distance below the first, should certainly remove any ground for such doubts. The principle here enunciated is, that if any large expanse below a dam or levee is to be covered, it is cheaper to cover it with water than with earth, and is equally effective.

T. G. Dabney.

Chief Engineer's Office, Yazoo & Mississippi Delta Levee District, Clarksdale, Miss., April 30, 1906.

[Our correspondent's record of experience in levee work must interest every engineer who has to face the problem of building dams or embankments on soft foundations. So far as the dam at Gatun is concerned, however, we doubt whether the suggestion would be practically applicable. Our impression is that below Gatun no favorable sites exist for the construction of even low dams. Further, while on their face Mr. Dabney's figures show a saving in total cross-section for the four low dams, as compared with the single dam at Gatun recommended by the Consulting Board of Engineers, yet the probable greater length of the dams below the Gatun site would probably cause the total yardage to be quite as much as for the single great dam. Besides this, the cost of preparing the foundation sites for the four separate dams would probably be much more than for the single dam.

Turning now to the recorded example of water working under a Mississippi levee through a stratum of sand and coming out in the cut banks of a bayou, it is proper to point out the essential difference in conditions between a river levee and a dam. In front of the former the river in flood is frequently eroding and cutting and laying bare new surfaces of permeable material which the water can enter. Behind a dam thrown across a sediment-carrying stream like the Chagres, the water is not only dead but it is constantly dropping fine sediment that tends to effectually seal the bottom of the reservoir. If at any particular place in that reservoir a stratum of permeable material like sand or gravel is exposed, the water will flow into this from all directions and carry with it the sediment that will shortly choke up the openings and cut off further flow.

With relation to the flow of water through permeable strata, there is one point to which particular attention should be paid and that is the relative resistance to flow at different points. In the case of the bayou cutting a deep sand stratum, mentioned by Mr. Dabney, it is likely that a large face of that stratum was exposed on the river side extending for a long distance up and down stream, to which the water found free entry, and thus reached the comparatively small face on the bayou bank with considerable pressure.

If a dam of pure sand were built across a river and the dam were wide enough in proportion to the head of water against it, the water would very slowly percolate through the whole dam and issue from its lower face, but at so slow a rate and at so low a pressure as to cause no erosion. Suppose in the same dam of sand a concrete core wall were built. The water flowing through the sand would be arrested by this core wall and the water pressure on its upper face would soon be equal to the head of water in the reservoir. If then any cracks existed in the core wall, the flow of water at nearly full pressure would pass through to the other side of the core wall, and being thus localized might wash out the earth in front.

For another illustration, a blanket of clay spread over the upper side of the supposed dam of sand would cut off all flow through it. The same blanket spread on the lower side would cause the water pressure to accumulate behind it until it would burst through the blanket at the weakest place.

Finally, returning to the actual conditions at Culebra, we are already on record as fully approving the adopted design of the Gatun dam and the lock level plan for the canal. If, however, it should be felt that some change is necessary in the plans because of the criticisms of this dam which have been made, the obvious thing to do would be to reduce the head of water behind this dam to say 60 ft. with proportionate reduction in the size of dam and area of the reservoir. Then at Bohio build a second dam, with a net head of water against it of only 25 ft., raising the water to the summit level of 85 ft. We discussed this alternative plan for the Panama works on page 519 of our last week's issue. Ed.]

Let us consider the Gatun problem in some detail.

The dam as contemplated is to be, say, 100 ft. high, with a crown width of 100 ft. and slopes of say 5 to 1 front and 20 to 1 back, giving a base width of 2,600 ft., with 85 ft. depth of water against it. Such a structure has a maximum cross-sectional area of 135,000 sq. ft. Here the bed of the channel is covered for a distance of 2,000 ft. below the crest of the dam by a superincumbent mass of earth feathering out to zero at its lower margin. Reliance is had upon this mass of earth overlying the territory below the dam to give stability to the foundation, a reliance which may be accepted as sound upon the authority of Mr. Stearns. Now suppose the dam should be made to carry a head of say 35 ft. instead of 85. Then the structure might safely be reduced to the following dimensions: Height, 100 ft.; crown width, 50 ft.; front slope, 4 to 1; rear slope, 6 to 1 down to the 50-ft. plane, and 4 to 1 below that plane. This has a maximum cross-sectional area of 52,500 sq. ft. Now locate a second dam at any convenient distance below the main dam, say half a mile. This dam could be made to carry a head of say 25 ft. Giving it a height of say 65 ft. with a crown width of 30 ft., a front slope of 4 to 1 and rear slope of 6 to 1 down to the 25-ft. plane, below which a slope of 4 to 1. The maximum cross-sectional area is 22,450 sq. ft.

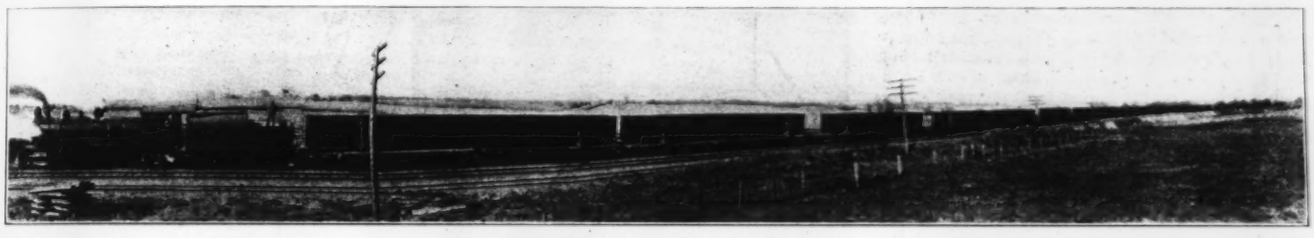
Construct a third dam at any convenient distance below dam No. 2, to carry a head of say 15 ft. Giving a height of 35 ft., crown width 25 ft., and the other dimensions in the same proportion as for the other dams, and we have a cross-sectional area of 6,900 sq. ft.

The remaining head of 10 ft. to be held by dam No. 4, with a height of 20 ft., crown width 20 ft. and slopes 4 and 6 to 1, making a cross-sectional area of 2,400 sq. ft. The sum of these four cross-sections is 86,550 sq. ft., as against 135,000 for the dam as contemplated.

No account is taken of any slope that may exist in the plane of the river bed, which would increase the quantities in the sub-dams in proportion to the degree of slope. As before stated it may be accepted on the authority of Mr. Stearns that the dam as contemplated will afford sufficient assurance of foundation stability, with an extension of its base some 2,000 ft. below the crest line. Furthermore it can hardly be supposed that there is any danger of the occurrence of leakage and the escape of water from the containing banks of the river's channel so as to threaten the integrity of the dam.

A TRAIN LOAD OF PLATE GIRDER BRIDGES.

The photograph herewith illustrates what is thought to be the largest single shipment of plate girder bridges ever made. The train consists of 56 cars, carrying 44 deck plate-girders, each 8 ft. high and weighing 20 tons, and it was run as a through train from the Pittsburg plant of the



A RECORD SHIPMENT OF PLATE GIRDERS.

McClintic-Marshall Construction Co., which built these girders, to Fremont, Neb. The girders were built for the Platte River bridge on the Burlington lines of the Great Northern Ry., the entire requirements of this bridge being 72 girders of this length. We are indebted to Mr. R. W. Knight, Contracting Engineer for the above company, for the photograph showing this notable train load.

STREET RAILWAY EARNINGS for the years 1904 and 1905 are presented for most of the principal systems of the United States in "The Financial Chronicle" for April 28, 1906. The gross and net earnings for 163 systems whose fiscal year corresponds with their calendar year is given separately and the totals, only, are given for a considerably larger number of roads, whose fiscal years expire on Sept. 30 or June 30. The totals for the several groups, and the grand totals for the 512 systems, with percentage increases for 1905, are as follows:

Street Railway Earnings in Thousands of Dollars.

	Gross		Net	
	1905.	1904.	1905.	1904.
For calendar year as below (163 roads) ...	$204,124	$186,278	$85,554	$76,452
For years ending Sept. 30 (88 roads)	21,918	21,332	8,173	7,498
For years ending June 30 (261 roads)	80,025	73,998	37,158	34,272
Grand total (512 roads)	$306,067	$281,609	$130,885	$118,222
Increase	24,458 (8.68%)		12,663 (10.71%)	

A HIGH-TENSION SINGLE-PHASE TROLLEY LINE is being built near Windsor, Ontario. The line will be about 35 miles long, and its trolley-wire will be supplied from the power station at Essex, with single-phase current at 6,600 volts. The trolley-line will be of the suspension-wire type. Five cars, equipped with two 100 HP. motors each, will be operated. The car equipment, together with a 500-KW. 25-cycle generator and the necessary complement of switchboards, exciters, transformers, etc., are being furnished by the Canadian Westinghouse Co., Ltd., to the Windsor, Essex & Lake Shore Rapid Railway Co.

SOME EFFECTS OF THE SAN FRANCISCO EARTHQUAKE ON WATER-WORKS, STREETS, SEWERS, CAR TRACKS AND BUILDINGS.

By Charles Derleth, Jr.*

Prof. Charles Gilman Hyde and the writer, representing the Department of Civil Engineering of the University of California, spent a number of days this week examining the earthquake damage to San Francisco's water supply. We were very courteously treated by Mr. Herman Schussler, Chief Engineer of the Spring Valley Water Co., who gave us every possible assistance and to whom we feel very much indebted for his advice and cooperation at this trying and busy time.

The region of maximum earthquake disturbance appears to lie along or near an old fault line which has been very closely studied by California geologists. As far as the writer has examined it, this line runs from Tomales Bay and Bolinas in Marin Co., in a south, southeasterly direction to the neighborhood of San Jose and Salinas. Just how far north and south of these points the disturbance may be found is a matter for further study and future reports, and really does not concern us at present. The earthquake of April 18 left a prominent scar without an interruption along this whole fault line. To an eye witness the effect is almost awe-inspiring. One can travel for miles along an almost exact right line and find the ground cracked and disturbed as though some giant had run a plow or a knife through it.

In Fig. 1 is given a map of the San Francisco peninsula, the northern peninsula of Marin Co. and a portion of the eastern shore of San Francisco Bay occupied by Oakland, Alameda and Berkeley. Upon this map I have traced by a dash and dot line, the line of fault or crack above referred to. It is rumored that this fault may be observed to run south to the Gulf of California, but there have been no authentic reports received as yet regarding its southerly limit.

Confining our attention to the San Francisco peninsula it is observed that the fault is in the ocean in front of the Golden Gate. It cuts the Pacific Coast line near Lake Merced and proceeds southward along a chain of small lakes between the San Bruno Mountains on the east and the coast ranges on the west. Continuing southward the fault runs through a long and narrow

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FIG. 1. MAP OF SAN FRANCISCO AND VICINITY, SHOWING WORKS OF SPRING VALLEY WATER CO. AND EARTHQUAKE FAULT LINE.

Fig. 2. Break in Pilarcitos Conduit, Spring Valley Water Works, Due to Earthquake.

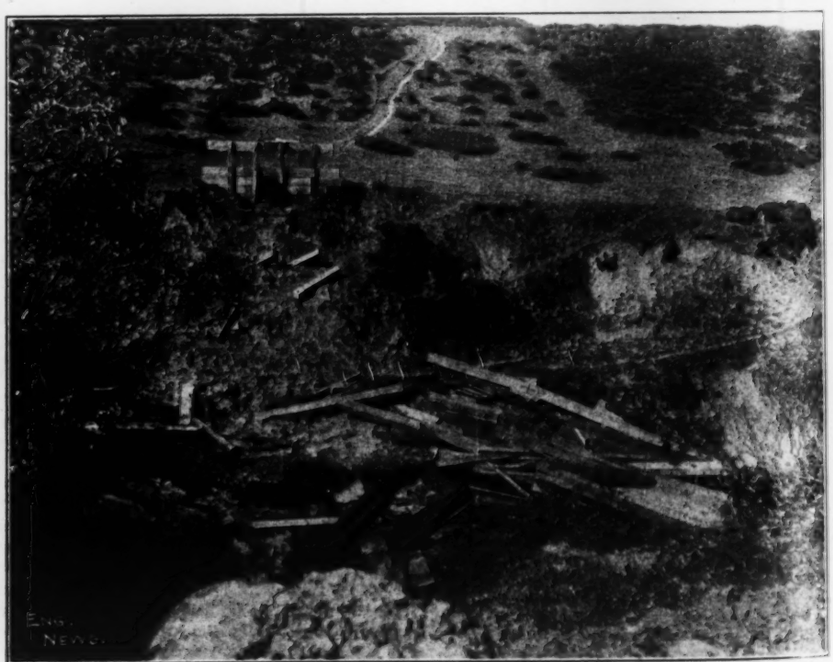

FIG. 3. DESTRUCTION OF TRESTLE BY EARTHQUAKE, PILARCITOS CONDUIT, SPRING VALLEY WATER-WORKS.

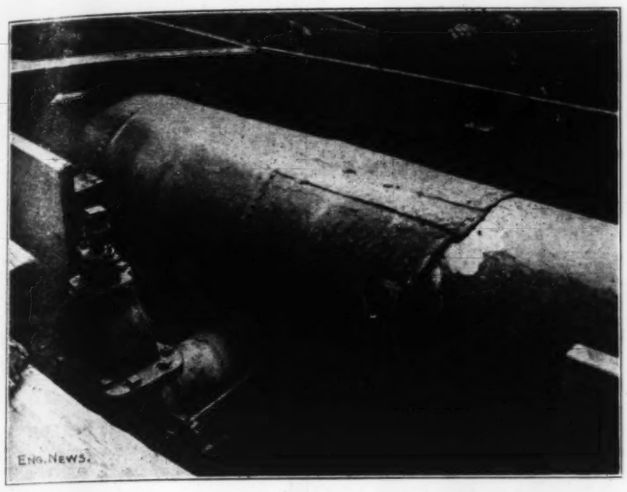

FIG. 4. PILARCITOS CONDUIT: TELESCOPED AND BLOW-OFF VALVE PARTLY TORN OFF.

FIG. 7. PILARCITOS CONDUIT: TELESCOPED, OUT OF ALINEMENT, BLOW-OFF VALVE TORN COMPLETELY OFF.

structural valley, passes along the east bank of San Andreas Lake, follows the valley below that lake and seems to run right through the longer diameter of the Crystal Springs Lake.

The writer carefully followed and plotted this line from Lake Merced to the southern end of Crystal Springs Lake and can vouch for the accuracy of that part of the fault line.

A number of scientists from Stanford University and the University of California are carefully studying the earthquake disturbance throughout the state and accurate reports are rapidly reaching Berkeley. It appears that the disturbance was more violent in the region of Tomales Bay than on the San Francisco peninsula. It was also decidedely more violent to the south in the neighborhood of San Jose and Salinas. The destruction to the property of the Spring Valley Water Co., therefore, was probably not so severe as it might have been had the works existed at Tomales Bay or near San Jose, and for that we may consider ourselves at least fortunate.

In general the worst effects of the earthquake are found close to the fault line above described. There are, however, some notable exceptions. To the north of San Francisco the towns of Inverness and Santa Rosa have been visited by great destruction. Santa Rosa is a considerable distance to the east of the fault line. A number of places near Monterey in the South have felt the "temblor" keenly. The problem is a complex one, and the center of disturbance, if there is just one center, is not now determined.

On Monday next, May 7, a general meeting of the members of the State Earthquake Investigation Commission will be held at Berkeley, at which time a conference of observers will bring to light definitely many important facts relating to this most interesting but destructive phenomenon.

Prof. Andrew C. Lawson, who holds the Chair of Geology and Mineralogy at the University of California, returned to-day from the region of San Jose, Salinas and Monterey and reports many interesting observations of value to structural engineers. I must not go into details regarding his observations at this time, and will therefore give but two examples of the earthquake destruction in the southerly region.

A bridge on the Southern Pacific Railroad crossing the Pajaro River within one-half mile of Chittenden Station, has been thrown from its bridge seats, though fortunately not off the piers. The piers are of concrete, with granite copings, and some of them have been cracked. The Spreckles Sugar Mill at Salinas, a heavy steel structure about 200 × 500 ft. in plan, has been wrecked, being buckled convex to the west and concave to the east, and is otherwise much distorted.

In the northerly region, Mr. G. K. Gilbert, of the U. S. Geological Survey, reports general destruction in the town of Inverness and speaks of one place where a road has been sheared so that the broken ends are 20 ft. out of alinement. I believe the road is on a fill. Such large motions are probably not found in the firmer rocks beneath. It is a general observation that only soft surface materials have been greatly distorted.

In your issue of April 26 (page 475) you show a skeleton diagram giving the reservoirs and main pipe lines of the Spring Valley Water Co. This diagram may be examined in connection with Fig. 1, herewith, which also roughly shows the main works of the Spring Valley Water Co. [Accompanying the earlier map are notes stating the composition of the various conduits.]

The writer has visited Pilarcitos, San Andreas and Crystal Springs reservoirs, also all of the important flumes and conduits connecting these reservoirs with San Francisco. He has had no opportunity to examine the Alameda conduit south of Burlingame, but is informed that all of the works along this part of the conduit and at its source of supply are intact and feels confident that such is the case, since all of that work lies in a region of lesser disturbance. The water supply of Oakland, Alameda and Berkeley, as I have already reported, is practically uninjured, and it is likely that the Alameda conduit south of Burlingame has been subjected to very nearly the same degree of shock as the works of the Contra Costa Co., of Oakland.

The Pilarcitos reservoir is to the west of the main fault line and is separated therefrom by a range of hills known as the Sawyer Ridge. That reservoir is thoroughly intact and its earth dam [95 ft. high] is unaffected. The waste-way conduit connecting it with San Andreas Lake is also intact. The reservoir is full of water.

The main fault line runs through Crystal Springs Lake, but in no way appears to have affected the imperviousness of its bottom, since the reservoir on May 3 was full of water. It is interesting to note that the fault line passes through the older dam, which separates the lake into two halves, but that dam is not seriously affected, and even if it were ruptured, there would be no danger, so far as it individually is concerned, to the impounding capacity of the whole reservoir.

All observations of the effect of the earthquake along the fault line convince the writer that there was an oscillating, shearing action of the surface materials, so that the material to the east of the fault line rubbed against that at the west. This shearing oscillation was not wholly horizontal, but must have had some vertical component. At this time, however, it is not possible to state the exact direction of action. Of course these surface movements must be due to a rupture in the hard materials beneath, but just what has occurred in the firm crust below is not entirely evi-

Fig. 5. Two Ruptures Near Together.

Fig. 6. Nearer View of One of the Ruptures.

FIGS. 5 AND 6. RUPTURES IN PILARCITOS CONDUIT.

dent. From Crystal Springs Reservoir to Lake Merced the surface ground usually is what is known as black adobe land. In places it is yellow adobe and sometimes it is a mixture of the two. This ground along the fault line has been subjected to tensions and compressions, and the earthquake has left permanent distortions and offsets.

The Pilarcitos conduit for a considerable distance practically coincides with the main fault line; indeed, one might almost imagine that the break in the ground was purposely staked out along the pipe line, or vice versa, from San Andreas dam to Frawley Gulch, a distance of about six miles. In this length the conduit is a 30-in. laminated wrought iron pipe of about $^{3}/_{16}$-in. metal, with transverse circular riveted joints. The rivets are $^{3}/_{8}$-in. in diameter. The center line of the pipe is usually about 3 to 4 ft. beneath the ground. In these six miles of length the pipe is ruptured in a great many places. At one point it is ruptured at a riveted joint by tension; at another by compression. The writer counted 19 such ruptures from a point A near the northern end of San Andreas Lake to Frawley Gulch at B (see Fig. 1). All ruptures occur at transverse riveted joints. There are some places where the pipe has collapsed; in one instance for a length of about 50 ft. There are no doubt many more ruptures that have not as yet been unearthed. Where the ground has been subject to resultant tension the pipe is pulled apart by amounts varying from almost nothing to as much as 5 or 6 ft. At compensating places where the resultant effect has been compression, the pipes are collapsed and telescoped by similar amounts. Fig. 2 shows a break in this pipe line near the up-stream end of Lake San Andreas. The pipe at this point has been pulled apart 53½ ins. A property fence crossing the pipe line about 10 ft. to the south of this rupture is offset 7 ft. along the fault line, the two pieces of fence remaining straight and parallel to their original direction. This decidedly shows that, in the vicinity, the surface ground to the west has been moved bodily to the north northwest relative to the surface material to the east of the fault line. Fence distortions are common along the fault line. At Frawley Gulch the conduit crossed a timber trestle, heavily built, about 100 ft. in length and some 25 ft. in maximum height. This trestle is about ¼ of a mile to the east of the fault line and the ground is firm adobe land, nevertheless the shock was so severe that it entirely demolished the trestle and pipe which it carried. The trestle seems to have vibrated in a vertical plane normal to its length and has been thrown down-stream to the southeast, as shown in Fig. 3.

I cannot speak of the Pilarcitos pipe line from this point to the city, as I have not examined that part of the line, but ruptures, if they occur, are probably not so numerous nor so serious. I might make the same remarks for that portion of the pipe near Pilarcitos Reservoir. The Pilarcitos conduit will no doubt be abandoned.

Figs. 4 to 7 show additional ruptures in the Pilarcitos pipe line between San Andreas Lake and Frawley Gulch. In Fig. 4 the pipe, supported on a timber framing, crosses a small swale. The pipe is telescoped 41 ins. and the blow-off valve connection is partly ripped from the conduit. Fig. 5 shows two ruptures a little to the north of the break in Fig. 4. At the point where the man is standing (Fig. 5) the fault line crosses the pipe line at an angle of about 45°. The pipe is sheared along the same angle, so that its parts are 20 ins. out of alinement and are moved toward each other 40 ins. Fig. 6 is a closer view of the same rupture. Fig. 7 shows the pipe crossing a small gulch. The blow-off valve situated at this point was stripped from the pipe and thrown 10 ft. eastward (to the left in the picture). The pipe was telescoped 49 ins. and thrown out of alinement, as shown. This rupture strikingly shows that the pipe metal was of high quality.

Since the earthquake, because of damage to the conduits, no water has reached the city from Pilarcitos, Crystal Springs or Alameda, and San Andreas Lake has temporarily become the distributing reservoir for the city, and probably will so continue in the future. The waters from Pilarcitos Lake, however, can flow to San Andreas through the waste-way pipe [illegible] connecting them. This pipe is unharmed, but [illegible] Pilarcitos water has not been needed. The [illegible] Andreas pipe line is now delivering water [illegible] the city. Relatively speaking, its injuries [illegible] very slight; only one important rupture has come to my notice. It was quickly repaired by putting a temporary band on the pipe.

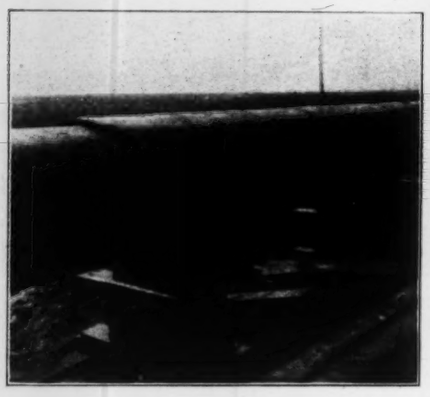

Fig. 8. Rupture, with Cross Blocking.

Fig. 9. Longitudinal Blocking.

FIGS. 8 AND 9. RUPTURE OF CRYSTAL SPRINGS CONDUIT ON SAN BRUNO MARSH, AND BLOCKING FOR REPAIRS.

Fig. 10. Exploded Gas Main, on Valencia St., near Market.

The fault line touches the eastern edge of the San Andreas dam, which dam is an excellent construction of earth and clay nearly 100 ft. [93 ft.] in height above the original surface of the ground. As an eye witness I am convinced that this dam was subject to a most severe earthquake shock, and since it retains the water of San Andreas Lake apparently just as well as before the earthquake, it should be a source of great satisfaction to its designer and builder. The ground is considerably scarred by cracks running north northwest on the eastern bank of the dam, where the nose of a hill naturally projects to form its abutment. These cracks, which are quite pronounced, are in the abutment and not in the dam itself. There are a few smaller cracks running in the same direction at the extreme westerly end of the dam. On the roadway of the dam there are some small longitudinal cracks, apparently due to the unequal

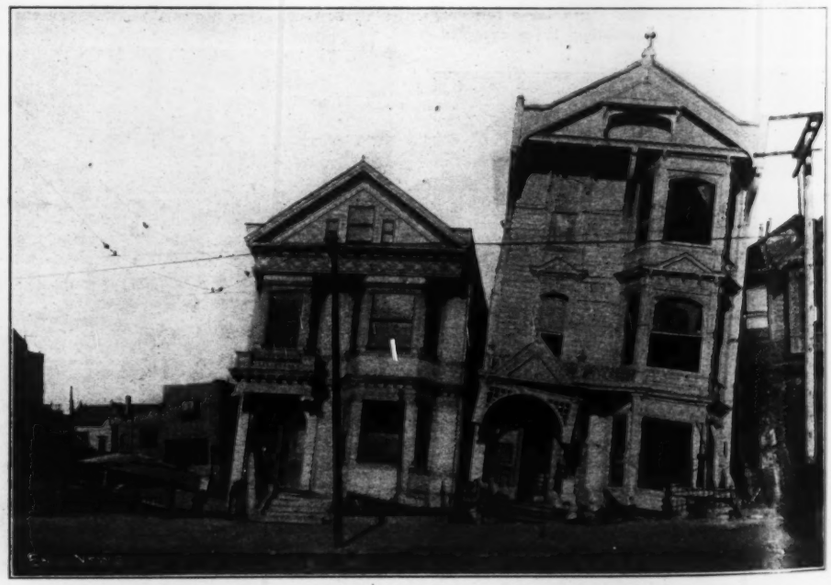

FIG. 11. THREE WRECKED FRAME HOUSES ON FILLED GROUND, HOWARD ST., BETWEEN 17TH AND 18TH.

FIG. 12. WRECK OF BRICK BUILDINGS.

settling of the triangular masses with respect to the core, but they are not serious. The writer is convinced that an earth dam properly constructed will stand a very violent shock, and he cannot praise too highly the construction of this one. A very careful study of this dam may throw some light upon the situation and problems to be solved at Panama, but there is no reason for discussing that subject now.

The flume from the Crystal Springs pumping station, which enters the San Andreas reservoir at the east end of its earth dam, has entirely collapsed at a point C, Fig. 1, just below that dam, where the main fault line intersects the flume. At this point the flume rests on a wood trestle of considerable height. As soon as this flume is repaired the waters from Crystal Springs Reservoir could reach San Andreas and thus be sent to the city.

The huge concrete dam at Crystal Springs [115 ft. above the natural surface], it will be at once seen, was subject to a series of thrusts and pulls in vertical planes along its length, since it is parallel to the fault line. It is the writer's judgment that the predominating effect has been a thrust. The dam has been very generously designed and is of great strength. Its inner face has a much heavier batter than the Rankine formulas require. So far as the writer could see, and he observed the dam carefully, there is not the slightest crack. The intake works, Crystal Springs pumping station and all accessory construction in the neighborhood of the dam are intact.

The Crystal Springs conduit at the time of writing is not supplying water to the city. It is mainly a 44-in. laminated wrought iron pipe, about ¼-in. in thickness with riveted joints, rivets ½-in. in diameter. This pipe is ruptured in a number of places, but mainly where it crosses the marshes. The worst destruction has occurred in a distance of about 1,600 ft., where the pipe crosses a marsh between San Bruno and South San Francisco. In this place the pipe rests upon a wooden floor, supported by pile bents. These piles on the average penetrate the mud to a depth of about 40 ft. It appears to the writer that this marsh shook like a bowl of jelly, the vibrations being mainly in a south southeasterly direction, or nearly at right angles to the length of the trestle. It appears that during the vibrations of the earthquake the trestle moved with mother earth, the pipe due to its inertia tending to remain quiet. As a result the pipe was alternately thrown from one side to the other of the trestle floor and its box covering was generally smashed. The pipe broke along transverse circular joints, sometimes by tension, sometimes by crushing. Fig. 8 gives a view of one of the ruptures on the San Bruno marsh and shows with what energy the Spring Valley Water Co. is repairing these great losses. On May 2, when the writer visited this pipe line, the work of repair had been already considerably carried out, and within a surprisingly short time the city will be receiving water through this large conduit. The figure shows the temporary redwood sills and blocking between the piles and the pipe. The stringers, not yet in place in Fig. 8, but shown in Fig. 9, two in number, consist each of three 2 × 12-in. sticks with 1-in. spacing. Planks are used, as larger timber was not quickly available.

In passing I might mention that San Mateo has been deprived of its water supply by the earthquake, but the town is not subject to a water famine, because the Spring Valley Water Co. has placed at its disposal 300,000 gals. per day, from the Crystal Springs conduit, since this conduit is not injured between Crystal Springs dam and the town of San Mateo. For fire protection the Spring Valley Water Co. has further provided the town with an additional supply and pressure. This is a period of trying needs for the San Francisco peninsula and vicinity, and it is a pleasure to a student of human nature to note with what energy and kindliness people who are all in trouble are stopping to help each other.

During the inspection of these works Professor Hyde and the writer made their headquarters at the Millbrae pumping station. At this station the company can command and direct the flow in all its conduits. Under normal conditions, by eight valves, housed four each in two small gate houses, one can command almost any combination of flow to the city from the four main sources of supply. The Millbrae pumping station is really an emergency plant, but at present it is a scene of the greatest activity. The region about Millbrae has been subjected to a very severe shock, but the Millbrae pumping station has been absolutely unharmed by the "temblor." I should observe that it is a practice of the Spring Valley engineers to use cement mortar for their brickwork, with selected brick, and to use careful proportions of cement, sand and stone of the highest qualities for their concrete. The brickwork and concrete of the Millbrae pumping station exhibit no cracks whatever. In striking contrast thereto one may see near the Millbrae station of the Southern Pacific Railroad the power-house for the trolley lines which run cars from Fifth and Market Sts. in San Francisco to San Mateo. This building is of cheap brick construction and has been almost utterly destroyed. Its north and south walls have entirely collapsed and the east and west walls seem to be held in place by the roof girders.

A few days ago the writer visited one of the smaller pumping stations of the Spring Valley Water Co. within the confines of San Francisco itself, and within a few blocks of the site of the Valencia Hotel. The Valencia Hotel, it will be remembered, was situated on Valencia St., near 18th, on filled ground, where once ran the old Mission or Islais Creek. The Valencia Hotel and other cheap brick and frame buildings in that region from Valencia to Howard Sts. very generally collapsed. Many lives were lost in the Valencia Hotel. To be sure the small pumping station above referred to is on firmer ground, nevertheless it was subjected to very decided shock, but there is not a crack in the brickwork of that pumping station, and the brick chimney is entirely intact. There are some slight vertical cracks near the base of the chimney, but these were produced a number of years ago, and were due to the expansion of the fire brick, which was not properly set by the mason. A steel band was at that time placed around the chimney in order to strengthen the structure against expansion. All of the brickwork in this pumping house is of selected brick, with cement mortar. The plant was able to run soon after the shock; has its own electric lighting and other necessary equipment.

It is plain that the water-works of the city of San Francisco have been subjected to a test more severe than the hand of man could devise. The water supply of a city is a most important matter, and ever since the earthquake the water problem has been the greatest one of many problems which have confronted the citizens of San Francisco. It is not surprising, therefore, that much concern should be expressed about the water situation, and it is easy to believe that the present task of the Spring Valley Water Co. is no small one from the engineering standpoint, and no enviable one from the municipal and political side. Having carefully examined the

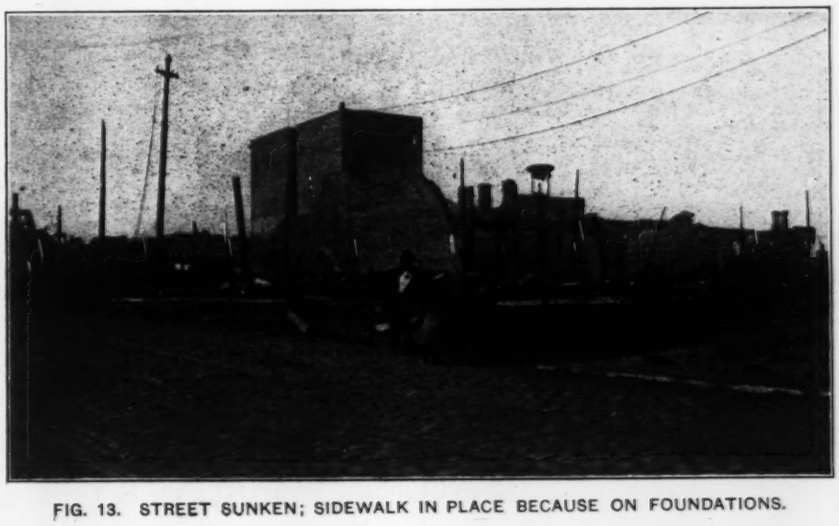

FIG. 13. STREET SUNKEN; SIDEWALK IN PLACE BECAUSE ON FOUNDATIONS.

FIG. 14. DEFORMATION STREET RAILWAY TRACKS, EAST AND PACIFIC STS., NEAR FERRY BUILDING.

FIG. 15. CRACK IN PAVEMENT IN FRONT OF FERRY BUILDING.

FIGS. 14 AND 15. VIEWS OF STREET DEFORMATIONS, SAN FRANCISCO EARTHQUAKE.

works, I feel it my duty to speak of the situation as I find it, and this I can certainly do without bias. The destruction to the Spring Valley Water Co.'s plant, as outlined above, has been produced by nothing less than a cataclysm: something which the mind of man could not foresee and whose effects no engineering structure, no matter how good, could resist. The Crystal Springs conduit to me seems excellent, but it was doomed on the marshes. The Pilarcitos pipe line had to succumb. It was right on the line of fault for a length of six miles, and the city should be thankful that its water-works engineers provided it with so complex and varied a system of conduits. It seems to me that the city has been saved from a terrible water famine simply because the San Andreas conduit survived the general destruction. Perhaps in the future it will be wise to avoid the marshes and made ground for important pipe lines. It seems to me also that the small reservoirs within the confines of the city should be connected with the main conduits by pipes of considerable size in no way connected with nor dependent upon the gridiron system of the streets. Had the city reservoirs of San Francisco tapped the large conduits independently of the street mains, some of the present delay in obtaining water and fire pressure might have been eliminated.

Earthquakes are not uncommon in California, and they will naturally occur again. There has been much talk of tapping the water sources of the Sierra Nevada Mountains and bringing that water to San Francisco by conduits and water courses which must be nearly 200 miles in length. In the light of our present catastrophe how much more danger must there be of earthquake destruction upon a line of so extended a length? Conduits in duplicate would be of no avail; if one breaks so will the other. The only safeguard would be two distinct conduits, running in widely separated districts, but such a proposition would entail great cost.

For safety the city needs a number of sources of water and a number of conduits so arranged that they will not tend to be destroyed all at the same time. The Spring Valley conduits have at least answered these requirements to such an extent that the San Andreas conduit survived. Buildings and other structures in San Francisco to a great extent have been notoriously poor and the time is ripe for the people of the Western metropolis to realize that they must enforce proper building laws and a proper attitude toward healthy construction, both in municipal circles and in private works. It is my opinion that the works of the Spring Valley Water Co. are relatively of an exceptionally high type of construction. Its wrought iron conduits after 30 years of use, even in their present demolished condition, exhibit surprising preservation. Its pumping stations have already been alluded to; they have survived where nearby structures have collapsed. The Crystal Springs dam needs no praise—it speaks for itself. The earth dam at San Andreas appears to fulfill its functions as well as ever, although it is directly on the line of main fault, and has been greatly scarred. It should be carefully examined.

Within the city's boundaries, main branch pipes and in general the pipes of the gridiron system, have been much destroyed. In the softer and made ground this is especially true. Moreover, the great extent of the fire destruction has left innumerable taps and service pipes to hundreds of burned buildings in a most dilapidated condition. Again, explosions of gas mains (Fig. 10) in many places have added further rupture to the streets and the pipes beneath them. With this general demoralization of the gridiron system within the city and the loss of the Pilarcitos and Crystal Springs conduits, the situation on the morning after the earthquake may be understood; there was little water in the city and no water pressure.

In the two weeks that have elapsed since the earthquake, the engineers of the Spring Valley Water Co. have been using San Andreas Lake as

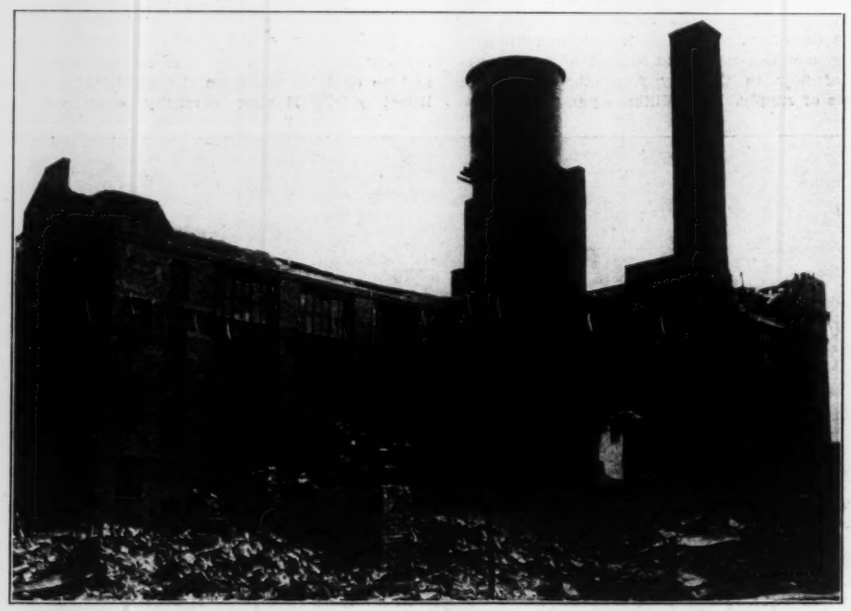

FIG. 16. CALIFORNIA ELECTRICAL CO.'S WORKS.
(Saved by private water supply and ribbed wire-glass in metal frames.)

Fig. 17. Hotel Alexander, under Construction, with Hotel St. Francis on the Right.

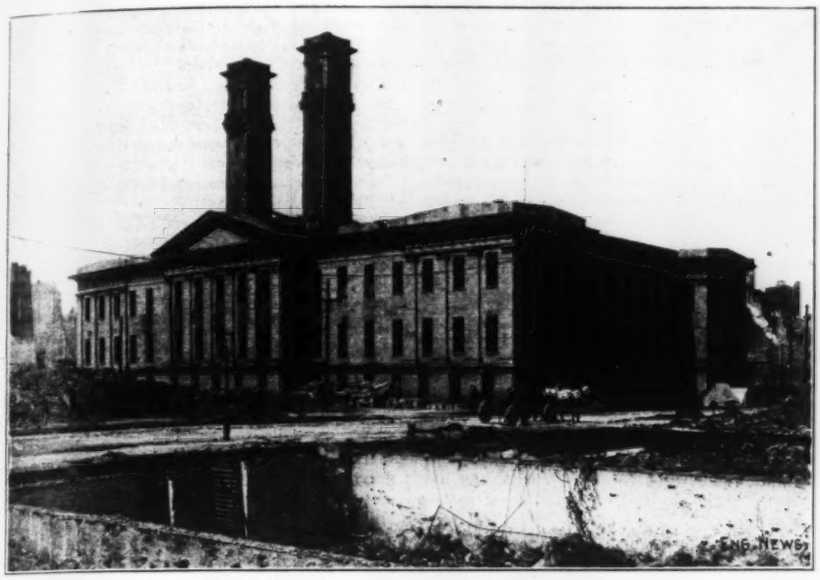

FIG. 18. THE U. S. MINT: AN OASIS IN AN ISLAND OF FIRE.
(Note cracks on right chimney.)

a distributing reservoir, and water has been forced with gradually increasing pressure into the city through the San Andreas conduit. The Crystal Springs conduit is also being repaired as fast as human energy can do so. To protect the western addition of the city from fire it was necessary to insure as quickly as possible a proper fire pressure. At Valencia St., between 18th and 19th, where everything was ruptured, a 16-in. cast-iron main was laid on the west side of the street to give pressure to the western addition at the same time that a 24-in. main was laid on the east side of the same street to repair the break in the pipe and force water into Market St. With much difficulty, by gradually increasing the pressure, water was forced down Market St. and along other streets of the business section, where numerous breaks were found, so that by May 1 water reached the Black Point pumping station, at Fort Mason, situated at the northerly end of Van Ness Ave. Since that time work has rapidly progressed so that at this writing water has reached most, if not all, of the city's distributing reservoirs, and the great danger from further fire is past. During the first week after the earthquake, however, the city was in a very precarious condition. During the first fortnight it was found necessary to deprive the people of the use of much water, naturally to their great inconvenience. It was necessary to adopt such measures to produce sufficient pressure in the crippled pipe lines to discover important leaks. The Spring Valley engineers were much criticised in those earlier and trying days. As the exact situation becomes more clearly understood the stand of the Water Co. will be more and more appreciated.

During the past week many rumors have been afloat regarding loss of water from the main reservoirs. These rumors, I believe, are now exploded. All of the reservoirs are full and the city practically has an unlimited supply of water.

The writer has collected a number of instructive photographs showing earthquake and fire destruction, and the following are here given:

Figs. 11 and 12 show destruction to ordinary frame and brick buildings. Fig. 11 shows frame houses on Howard St., between 17th and 18th, on filled ground. The house at the extreme left has entirely collapsed.

Figs. 13, 14 and 15 show typical deformations of streets. Fig. 13 shows a drop in Howard St. Where the men are standing a sidewalk on foundations has remained in place. Fig. 14 shows destruction of car rails and street surface, corner East and Pacific Sts., near the Ferry Building. Fig. 15 is a similar view in front of that building.

Fig. 16 shows the California Electrical Co.'s Works at Folsom and Second Sts. The cornice is gone, the chimney and wall near it have almost collapsed, but the building has been saved from fire by its local water supply and wire-ribbed glass windows with metal frames. I have spoken of this building in detail in a previous letter.

On the west side wall of the Merchants' Exchange Building, a Class A building of 13 stories, areas of face brick have been thrown down, leaving the rougher brick and sometimes the steel frame in view. These areas are perhaps ten bricks in height and of variable but considerable length, say 10 to 30 ft. With a proper bond, for example the Flemish bond, for the face brick, such ruptures could not have been produced by the "temblor." The scarred wall of the Merchants' Exchange shows that the face brick have been chipped off here and there on their backs and a brick from behind thrust outward diagonally. This is the only bond provided for the facing brick. The practice is too common and certainly should meet with disfavor in San Francisco.

Fig. 17 shows the Hotel Alexander, with the Hotel St. Francis on the right. The Hotel Alexander, which was just nearing completion, is not scarred by the earthquake. Upon its side wall will be seen the heads of numerous tie rods which may help to explain the freedom of that wall from earthquake cracks. The building is surprisingly preserved from fire.

Fig. 18 shows the U. S. Mint, corner Mission and Fifth Sts. This building was saved from fire; everything around it being destroyed. It is unmarred by the earthquake, except at the base of the chimney towers. The picture shows cracks in view on the right chimney.

The front of the California Casket Co., on Mission St., near Seventh, shows earthquake cracks in different parts of the face. The side brick walls are considerably cracked, especially at the rear, by the earthquake. Fire has not done much damage to the building, possibly because surrounding structures were small wooden shacks which burned away quickly. Its floors and partitions are all Roebling construction. Concrete floors and partitions stood the earthquake and fire very well. The direct reverse may be said of hollow tile floors and partitions. The hollow tile partitions of the general Post Office have been dreadfully shattered by the earthquake. In the Mills Building the hollow tiled floors and partitions have been completely ruined by fire. Safes on the upper floors have fallen clear through to the cellar. Terra cotta and tile cannot compare with concrete for earthquake and fire resisting purposes. Fig. 19 shows a view in the basement of the Mills Building. The fire was hot enough in this basement to bulge and bend some of the steel columns very badly.

The north wall of the Fairmount Hotel has ugly earthquake cracks in the terra cotta face above the granite of the main floor.

The Appraisers' Building, corner Sansome and Washington Sts., has an excellent foundation and heavy brick walls 3 ft. in thickness, said to be reinforced by rods. It has been saved from fire and shows practically no earthquake cracks; nevertheless the building on the left has been utterly ruined by the earthquake. Brick buildings properly constructed, with good bond and cement mortar, and resting upon foundations acting as units, can withstand heavy earthquakes, as is seen in this view, and as other structures, like the Palace Hotel, have emphatically proved.

Cracks are to be seen in the first story stonework of the Flood Building. There are also cracks of the same nature in the St. Francis Hotel. These cracks were produced by the earthquake, and can be found in most high buildings in San Francisco. Some are more visible than others.

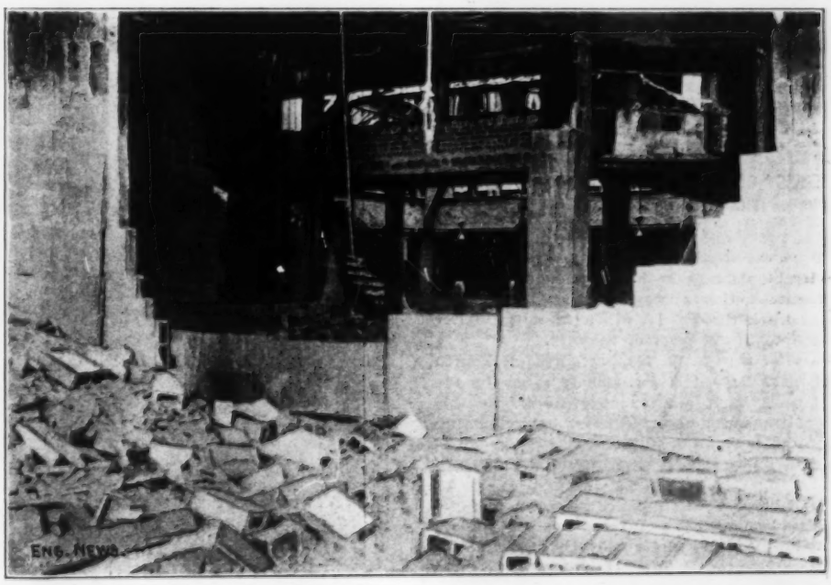

FIG. 19. FIRE WRECKAGE IN THE BASEMENT OF THE MILLS BUILDING.

FIG. 20. GENERAL WRECKAGE OF CAR TRACKS, SEWER, WATER AND GAS PIPES, HOWARD AND 17TH STS., SAN FRANCISCO.

The Monadnock Building is located on the south side of Market St., between the Palace Hotel and the Call Building. The space between the Monadnock and the Call buildings was occupied by the Hearst Building, which has been entirely demolished. The Monadnock is a new structure and was nearing completion at the time of the earthquake. It represents a fair example of average hige office building construction. The brickwork is badly cracked from top to bottom along the corner of the building. On the front face there are a number of ugly X-shaped cracks between windows, clearly seen in the photograph. It is reported that an attempt was made by the fire fighters to dynamite the Monadnock, which may explain the severity of the cracks, but the earthquake was capable of producing them in that building. Other fireproof buildings, for example, the Rialto Building, were dynamited. I cannot understand why attempts were made to blow up such structures. A so-called fireproof building should retard the progress of the flames. We ought not, however, even to appear to be criticising the men who fought the conflagration that first awful night. One conclusion from the fire ruins is clear: No structure is proof against a great conflagration.

The addition to the Chronicle Building, also just nearing completion, shows X cracks on the brick front similar to those on the Monadnock Building.

Fig. 20 shows a street view, taken April 25, at the corner of Howard and Seventeenth Sts., where the ground was much distorted. The car tracks are twisted out of shape, the brick sewer is broken and the water and gas pipes are wrenched and snapped. A redwood plug has been driven into the broken water main, but the pipe is badly leaking. Views of this kind were common in the first week after the fire.

THE EFFECT OF THE EARTHQUAKE ON STREET CAR TRACK IN SAN FRANCISCO.

By C. M. Kurtz.*

The recent earthquake in San Francisco did considerable damage to the street car tracks, and the accompanying photograph shows the worst case of track thrown out of line that the writer has noticed in any part of the city.

The view was taken looking north on Fourth street, near Bryant street, shortly after the fire had burned itself out in the vicinity. As this piece of track was observed hours before the fire devastated both sides of the street of the buildings, it is impossible to attribute the distortion to heat.

It will be observed in the illustration that the right hand or north bound track was being relaid by the heavy (9-in.) girder rails, the ties of which rested on the ground, but were imbedded in 7 to 8 ins. of broken rock concrete. The old track, consisting of the flange rails (4¼ ins.) connected to the ties by means of the cast iron chairs, was firmly wedged into the stone block pavement by years of heavy traffic.

It seems that the predominant waves of the earthquake ran longitudinally with the track and succeeded in loosening the heavy girder rails away from the ties and concrete to a point about 12 ft. from the end of the concrete filling. Here the force transmitted from the rails to the ties was so great as to displace the imbedding concrete, pushing it towards the foreground about 6 ins.

On account of the absence of anything in the space between the new track and old pavement to hold the portion of the track in line laterally, and the strong resistence offered by the old track in the block pavement, it seems that the powerful thrust imparted to the girder rails by the earthquake waves bent both rails of the track as shown, considerably beyond the elastic limit of the steel. Then the girder rails evidently sprang back to their original position longitudinally, dragging back the ties that had pushed portions of the concrete ahead and left 6 ins. of space at the joints between the new and old rails.

The common type of track distortion caused by the earthquake waves is also shown in the view on the left hand track. Here both rails are bent upward about 5 ins. in 3 ft. The rails bend up in cases of this kind, because of the resistance offered in every other direction by the ties, pavement and track itself.

*1305 Alice St., Oakland, Cal.

NOTES FROM THE ENGINEERING SCHOOLS.

THE PRATT INSTITUTE OF BROOKLYN, N. Y., maintains a free public library located on Ryerson St., near De Kalb Ave. In the Applied Science Reference Room of this library nearly a hundred trade and scientific journals are kept on file and there is an extensive collection of reference books relating to various industrial processes and a file of trade catalogues.

UNIVERSITY OF ILLINOIS.—Tests of Illinois coals are about to be made on a comprehensive scale at the Engineering Experiment Station, for the purpose of determining the most [illegible] methods for their utilization. Tests of [illegible] be made, (a) under power plant boiler[s] (b) residence heating boilers; (c) in gas [illegible] (d) to determine their chemical compo[sition] heating values. A feature of special s[ignificance] in connection with these tests is the org[anization] of a special conference committee, the [members] of which are as follows:

(1) H. Foster Bain, Director State Geolog[ical survey], Urbana, Ill. (representing the State Geologic[al survey]); (2) A. Bement, Consulting Engineer, Chicago (West-ern Society of Engineers); (3) Edwin H. Ch[ester] Presi-dent Fuel Engineering Co., Chicago (the Bui[lding] Man-agers' Association of Chicago); (4) F. H. [Gen.] Supt. Motive Power, C. B. & Q. Ry., Chicago (West-ern Railway Club); (5) Adolph Mueller, Pre[sident] C. H. Mueller Mfg. Co., Decatur, Ill. (the Illinois M[anufactur-ers' Association); (6) Carl Scholz, President [Kalley] Mining Co., Chicago (the Illinois Coal Operator[s Asso-ciation); (7) A. V. Schroeder, Gen. Supt. Electri[c Light & Heat Co., Springfield, Ill. (the State Elec[tric Light Association); (8) W. L. Abbott, Chief Operating [Engineer] Chicago Edison Co., Chicago (the Board of [Trustees] University of Illinois); (9) R. S. Wallace, Chief [Engineer] Peoria Gas & Electric Light Co., Peoria, Ill. (the [Illinois] Society of Engineers and Surveyors); (10) L. P. [Breckin-]ridge, Director Engineering Experiment Station, [Uni-]versity of Illinois, Urbana, Ill.

UNIVERSITY OF WISCONSIN.—The sixth annual session of the Summer School for Artisans, held under the direction of the College of Engineering, opens June 25, and continues for six weeks.

This school offers to those unable to take a regular four years' course an opportunity of obtaining a working knowledge of the methods of testing, and the use of instruments, together with such theoretical principles in each case as the nature of the subject and the preparation of the student, the requirements for admission not extending beyond a working knowledge of English and arithmetic, may permit.

Correspondence students have found this school of value in giving an opportunity for laboratory practice along the lines in which they have had theoretical instruction.

A bulletin describing the work of the School for Artisans in detail will be sent on application to Frederick E. Turneaure, Dean, College of Engineering, Madison, Wis.

A DEADLOCK IN THE SENATE CANAL COMMITtee over the type of the Panama Canal is reported to have occurred on May 12. Those voting for the lock canal were Chairman Millard and Senators Hopkins, Dryden, Knox and Simmons. Those favoring the sea-level canal were Senators Kittredge, Platt, Aukeny, Morgan and Taliaferro. Senators Carmack and Gorman were not present; but it is said that the former, although he has attended few of the hearings, favors the sea-level plan.

THE VOTE ON THE METRIC SYSTEM preamble and resolutions reported by the Standardization Committee of the American Institute of Electrical Engineers at the Director's meeting of March 23, 1903, and submitted to

STREET CAR TRACK ON 4TH ST., NEAR BRYANT, SAN FRANCISCO, DISTORTED BY EARTHQUAKE.

the membership in the United States, numbering about 3,300, for a letter ballot on April 5, 1906, shows the following results. Up to May 5 there had been received 1,747 votes, of which 1,569 were in favor of the resolutions and 178 against them. This vote is not to be considered as the official action of the institute, but simply a test of the views of those members and associates who were sufficiently interested in the matter to cast a vote. The result of this ballot has been transmitted to the Congressional Committee on Coinage, Weights and Measures, at Washington.

The resolutions voted upon by the membership follow:

Whereas, The Metric System of Weights and Measures offers very great advantages by its simplicity, consistency, and convenience in every-day use, as well as in engineering and scientific calculations and computations; and

Whereas, These advantages have already been demonstrated by the universal adoption and entirely successful use of the Metric System in all civilized countries, except Great Britain and the United States; and

Whereas, All the electrical units in universal use, such as the volt, ampere, ohm, watt, etc., are metric units and

Whereas, The industrial use of these electrical units would be much facilitated by the general adoption of the metric system.

Resolved, That this Committee unanimously recommends the introduction of the metric system into general use in the United States at as early a date as possible without undue hardship to the industrial interests involved.

Resolved, That this Committee favors such legislation by Congress as shall secure the adoption of the metric system by each department of the National Government as speedily as may be consistent with the public welfare.

F. B. Crocker, Chairman.

February 27, 1906.

CHANGES IN LAND ELEVATIONS at New York City are discussed in a recent report to the Municipal Engineers of the City of New York by a committee appointed to investigate the relation between the different datum planes used by public authorities in that city. The committee concludes that no evidence is revealed which would support the view that progressive changes in land elevations referred to sea level are taking place at New York. The passage in question is:

A good deal of discussion has arisen about a supposed settlement of the land at New York and some have maintained that our datums would have to be changed from time to time to keep pace with this change. It is maintained that New York City is settling into the ocean at the rate of one foot or more per century and that, in course of time, our city will have to be raised out of the waves like Galveston. Let us examine the evidence. First, we have the Navy Yard bench only 4.4 ft. above M. H. W. instead of 5 ft., but this 5 ft. was only "conventional," and might really have been determined by a few observations and the coping assumed at 5 ft. for convenience, a very good thing to do in the absence of accurate observations. So this evidence is open to doubt. Then we have the change in the Dock Department datum of 0.24 ft., but this would only be 0.05 ft. for M. T. L. as we have shown, and even this difference is due to a better series of observations. Then, the marshes along the ocean front of Staten Island and Long Island are lower, we are told, and encroaching on the upland. This may well be, as we know that there is a continual compression of this kind of marsh, which lowers its relation to the sea. This is shown on a large scale in Louisiana, where the settlement of marsh land is rapid. However, the Dock Department records seem to show an upward movement of M. L. W., which would indicate a downward movement of the land for a long period. But the height of the tidal wave above and below M. T. L. is profoundly affected by the configuration of the rivers, shores and depth of water, and as the harbor of New York has undergone great changes in the past twenty-five years, due to the filling in of the shores and the deepening of channels, we might expect changes in M. L. W. and M. H. W., especially, also, as the channels into the bay are freer and tidal basins to be filled less. The observations at Sandy Hook do not show an appreciable change in M. S. L., and we have shown that the change recorded at Pier A for M. T. L. was only 0.05 ft. against 0.26 ft. for M. L. W. Tidal observations are also greatly affected by winds, which, if continued over a long period, may affect the apparent level of the ocean for a corresponding period, so that it takes many years to establish a M. T. L. free from effects of winds, etc. The conclusion is that the change in the level of the land at New York is far from proved, and, although there is probably some change, it is very small and not of a constant rate or of a constant sign.

The committee also refers to studies of automatic tide-gage records made by Mr. G. W. Tuttle, of New York City, a few years ago, noted in our issue of Dec. 10, 1903, p. 520. Mr. Tuttle concluded that sea-level shows oscillatory variations relative to the land, of a period of about 8 yrs.

THE SETTLING OF THE CITY HALL at Chicago, due to the construction of the foundations for the County Building, adjacent to it, has been investigated by engineers, and it is reported that there is no fear of collapse or serious injury. Floors have warped in some places, and the fracture and falling of some of the decorative features of the interior and exterior have caused apprehension as to the safety of the structure. The north and south entrances have been temporarily closed, until the completion of the foundation work of the adjoining building. These new foundations are of the deep caisson system now commonly employed for large buildings in Chicago, large wells being sunk through the clay bed to hard bottom and then filled with concrete. As these wells extend far below the level of the foundations of the City Hall there have been some movements of the clay bed, causing settlement of some parts of the City Hall.

Some further falls from ceilings, etc., caused a slight scare after the engineers had made their report, and on May 10 some of the officials prepared to move their offices out of the building. Another investigation was made, as a result of which they returned to their quarters. It is thought that some of these falls may have been due to too vigorous work on the part of the men engaged in removing loosened stones and decorative work. The total settlement has been only about 2½ ins., and as the wells for the County Building foundations are now finished and filled with concrete no further movement is expected, except perhaps at the south end, where a sub-basement is to be excavated for the County Building. The architects and engineers of this building, however, are of opinion that this is not probable. As the settlement of the City Hall has been almost entirely along its east side, and as it seems that some of its girders have not (and never had) a sufficient bearing in the walls, heavy tie rods are being put through the building to hold the east and west sides together. It may be noted that the City Hall and County Building formed practically one structure, H-shaped in plan, the latter being on the east and the former on the west side. Owing to a generally dilapidated condition (due partly to poor construction under political conditions) the county authorities decided last year to erect a new building, and strong efforts were made to have a new City Hall built at the same time and in cooperation with the County Building. These were unsuccessful, however, and the deep foundations for the new steel-frame County Building are now practically completed. It is this work which has affected the adjacent City Hall, with its shallow foundations.

STRUCTURAL DRAFTSMEN in search of employment are advised not to go to San Francisco at present. A letter from a prominent engineer in San Francisco says:

I shall be glad if you will note in your paper that there seem to be plenty of structural draftsmen in San Francisco just at present, and that it will be a mistake for any more to come West on the hope of obtaining work here until the rebuilding is further advanced than at present.

THE STATE BOARD OF ARCHITECTS of California issued a report on May 2, from which the following is taken:

The State Board of Architects has the following suggestions to make in relation to the restrictions of the coming building ordinances. Thorough inspections and investigations have been made through the burnt district, and it has been found that safety is not a question of style of architecture, but quality of workmanship.

Cornices and arches need not be excluded from the new city. Where they were properly anchored and built they withstood the shock and the fire both. It is the opinion of the board that the city beautiful need not be without its picturesque cornices and decorations. The Call and Kohl buildings are proof enough that good work on decorations will insure them against destruction.

The pile foundation has been found to be the most substantial. In the earth's vibrations it rests as does a ship in water. And the building rests securely upon it. Forty-five feet is advised as a safe depth for either pile or concrete foundations.

The height makes no difference in the matter of safety. Any building supported by what is known as the cage steel frame will withstand any ordinary number nine shake. It is necessary that San Francisco have its high buildings. With proper workmanship they can be built in such a way that they will be absolutely safe.

Bay windows are not considered safe. And, though it is strongly urged that decorations be permitted, few projections should be allowed.

It is considered that the Ferry Building sustained the most severe shock of any in San Francisco. Yet inspection shows that it is good for several more shakes such as the one of April 18th. The tower is included in this statement.

A REPORT ON NIAGARA FALLS has just been made by the International Waterways Commission, although the American and Canadian sections of the commission made separate reports to their respective home governments some weeks ago. The substance of the report of the American section was printed in our issue of April 5, 1906, p. 394. The full commission's report makes the same recommendations as to limitation of draft which were made by the American section, namely:

American side	18,500 cu. ft. per sec.
Canadian side	36,000 cu. ft. per sec.
Chicago Drainage Channel	10,000 cu. ft. per sec.

Lockage water for Erie and Welland canals as needed.

The commission, while not fully agreed as to the effects of draft of water upon the scenic beauty of the falls, is agreed on two main points, (1) that the scenic effect of the falls should not be destroyed, and (2) that a draft greater than that above specified would injure the beauty of the falls as a whole. As franchises have already been granted for power development which will consume the above-named amounts in the aggregate, the conclusion that no further draft should be authorized was easily reached. But the Canadian section joins in these recommendations only in connection with the following principles, which it holds must be a part of any treaty or arrangement for the preservation of Niagara Falls:

First—In all navigable waters the use for navigation purposes is of primary and paramount right. The great lakes system, on the boundary between the United States and Canada, and finding its outlet by the St. Lawrence to the sea, should be maintained in its integrity.

Second—Permanent or complete diversions of navigable waters or their tributary streams, should only be permitted for domestic purposes and for the use of locks in navigation canals.

Third—Diversion can be permitted of a temporary character where the water is taken and returned again, when such diversions do not interfere in any way with the interests of navigation. In such cases each country is to have a right to diversion in equal quantities.

Fourth—No obstruction or diversion shall be permitted in or upon any navigable water crossing the boundary or in or from streams tributary thereto which would injuriously affect navigation in either country.

Fifth—Each country shall have the right of diversion for irrigation or extraordinary purposes in equal quantities of the waters of non-navigable streams crossing the international boundary.

Sixth—A permanent joint commission can deal much more satisfactorily with the settlement of all disputes arising as to the application of these principles, and should be appointed.

The Canadian section also holds that any treaty or arrangement for the preservation of Niagara Falls should be limited to 25 years. It is not apparent from the report whether or not the Canadian section also favors limiting the above-quoted principles to the same term of years.

THE FERRIS WHEEL was destroyed May 11 by the wreckers at the St. Louis Exhibition, as it was estimated that it would have cost $40,000 to take it down, and there seemed to be no further use for it. The foundations on one side were blown out by dynamite, the intention being to throw the wheel over to one side, but according to the press reports this only dropped the wheel on the ground (a very short distance) when it at once collapsed into a scrap heap some 30 ft. high. The wheel was designed and built by the late G. W. G. Ferris, of Pittsburg, as one of the features of the Chicago Exhibition of 1893, and the concession company which operated it is said to have taken in $750,000, charging 50 cts. a ride in the large cars suspended from the rim. The wheel was afterwards removed to a summer park resort in Chicago, but did not prove an attraction, and remained practically neglected until 1903, when it was removed to the St. Louis Exhibition. The wheel was 250 ft. diameter, consisting practically of two wheels 28 ft. 6 ins. apart, braced together and carried by a 33-in. axle on towers 137 ft. high. It weighed about 4,300 tons. It was described in our issue of April 13, 1893, and in later issues its strains and general design were discussed.

PERSONALS

Mr. Geo. E. Otis has been appointed Principal Locating Engineer of the Atlantic & Birmingham Construction Co., with headquarters at Atlanta, Ga.

Mr. F. M. Martin has left the Mathieson Alkali Works, of Saltville, Va., to become Engineer for the Western Engineering & Construction Co., of Edmonton, Alberta, Canada.

Mr. V. E. McBee has been appointed Assistant Engineer of the Seaboard Air Line Ry., to succeed Mr. C. R. French, resigned. His headquarters are at Birmingham, Ala.

Col. Charles R. Suter, Corps of Engineers, U. S. A., was retired from active service May 5 and placed upon the retired list of the army, with the rank of Brigadier-General.

Mr. H. H. Harman has been appointed Acting Engineer of Bridges of the Bessemer & Lake Erie R. R., to succeed Mr. F. R. Layng, promoted to Engineer of Track, to succeed Mr. E. J. Randall, Principal Assistant Engineer, resigned.

Mr. Frank C. Faust has been appointed Superintendent of the Fourche River Valley & Indian Territory Ry. In addition to his duties as Chief Engineer he will have charge of the maintenance and operation of the company's lines.

Mr. Ralph B. Hayward, Manager of the Pittsburg Office of the B. F. Sturtevant Co., has resigned to accept the management of the Chicago Branch Store of the Buffalo Forge Co. This headquarters will be 54 to 60 S. Canal St., after June 1.

Mr. Arthur J. Vance, Superintendent of the Southern Engine & Boiler Works, of Jackson, Tenn., will assume charge of the Buffalo Forge Co.'s interests in the Cincinnati district on June 15. Mr. Vance was formerly Cleveland Manager for the Buffalo Forge Co.

Mr. Henry W. Lewis, for two years with Mr. C. C. Vermeule as Assistant Engineer on the new water supply system of Hudson, N. Y., has accepted the position of Superintendent of the Gifford-Wood Co.'s foundry at Hudson, N. Y. This company manufacture ice-handling machinery.

Mr. John F. Wallace, former Chief Engineer of the Panama Canal, has accepted the Presidency of the Elec-

trical Properties Co. This company was recently incorporated under the laws of the State of New York, and will take over the interests of Westinghouse, Church, Kerr & Co.

Mr. A. N. Bullitt has resigned as Chief Engineer of the Virginia & Carolina Coast R. R. to accept the position of Chief Engineer of the Pittsburg, Binghamton & Eastern Railroad Co. This company is to build a line approximately 225 miles long between the cities of Binghamton, N. Y., and Pittsburg, Pa.

The following changes have taken place in the Reclamation Service: Mr. Louis W. Hall has been appointed Engineer by transfer from the War Department and assigned to duty on North Yakima Project, Wash.; Mr. Wm. B. Saunders has been appointed Assistant Engineer and assigned to duty with Mr. J. Ahern, of Shoshone Project; Mr. W. G. Swendsen, Engineering Aid, has resigned from the service.

Mr. Philip Burgess has been appointed Special Assistant Engineer of the Engineering Department of the Ohio State Board of Health. He will make an investigation into the construction, methods of operation and efficiency of all existing water purification plants in Ohio. This investigation is being made by the Board of Health in accordance with a recent act of the State Legislature.

Mr. John M. Bramlette, General Manager of the Philadelphia & Western R. R., has resigned to become General Superintendent of the Michigan United Railways Co. In accepting his new position Mr. Bramlette becomes the highest salaried railway superintendent in the State of Michigan, and will be in charge of about 200 miles of street railways in the cities of Lansing, Battle Creek, Kalamazoo and Jackson. He will have offices both at Kalamazoo and Lansing, Mich.

Mr. Wm. Clegg, Jr., who has been Special Agent of the Westinghouse Electric & Mfg. Co. in their St. Louis territory, has been appointed Acting Manager of the St. Louis office, to succeed Mr. D. E. Webster, formerly Manager, who has been transferred to a position in the Chicago sales office. Mr. J. S. Tritle has been appointed Acting Manager of the new district office opened in Rooms 512 and 513 New England Building, Kansas City, Mo. Mr. Tritle was formerly connected with the St. Louis office.

Prof. W. K. Hatt, Professor of Applied Mechanics at Purdue University, has been appointed Professor of Civil Engineering, to succeed Prof. W. D. Pence, resigned. Prof. Hatt is a graduate of the University of New Brunswick in the Arts Course and of Cornell University in Civil Engineering, and had taught in both institutions before joining the faculty of Purdue University. The organization of the Laboratory for Testing Materials will be incorporated with that of the School of Civil Engineering, so that it may continue to have the benefit of Prof. Hatt's direction. Prof. Hatt will also continue to act as Consulting Engineer for the Forest Service, United States Department of Agriculture, Washington, D. C.

Mr. Hiram F. Stevens, Vice-President and General Manager of the Central New York, Empire State and New York & Pennsylvania Telephone & Telegraph Companies, has resigned as General Manager of these companies to become Vice-President of the Central New York, Empire State, New York & Pennsylvania and Hudson River Telephone & Telegraph Companies. Mr. Walter W. Nicholson, General Superintendent of the Central New York and Empire State Companies, has been promoted to General Manager of these companies, the office of general superintendent being discontinued. Mr. L. S. Greenleaf, General Superintendent of the Hudson River Co., is promoted to General Manager, while Mr. E. B. Rogers, General Superintendent of the New York & Pennsylvania Co., is made General Manager of this company. Mr. B. C. Wolverton, Chief Engineer of the Central New York and Empire State Companies, is also made Chief Engineer of the Hudson River Co. The headquarters of these officers are at Syracuse, N. Y., as heretofore.

Obituary.

Robert L. Holliday, Superintendent of the Delaware Division of the Pennsylvania R. R., died suddenly of apoplexy, at Dover, Del., May 12, aged 58 years. Mr. Holliday was a graduate of the Rensselaer Polytechnic Institute of Troy, N. Y., entering the railway service upon graduation. Since 1876 he had been connected with the Pennsylvania System, serving in the following positions: Assistant supervisor Division No. 10, Pittsburg; assistant engineer, Division No. 4, Philadelphia; assistant engineer, Pittsburg Division; engineer of maintenance of way, Pennsylvania System, with headquarters at Altoona; superintendent of Bedford Division; superintendent of Central Division of Philadelphia, Washington and Baltimore, and finally superintendent of the Delaware Division.

Chevalier Charles Baillairge died at his home in Quebec, Canada, May 10, after an illness of two years. Mr. Baillairge was Joint Architect, 1883 to 1890, with the late Thomas Fuller and the late John Page, for completing the Parliament and Departmental Buildings, and designed and superintended the construction of many other public buildings. He was also City Engineer of Old Quebec for some 33 years. He was one of the eighty charter members of the Royal Society of Canada, first President of the Corporation of Land Surveyors and Civil Engineers of the Province of Quebec, Vice-President of the Quebec Association of Architects and member of several other scientific societies. He was the author of a treatise on geometry and mensuration, besides many scientific memoirs and articles. He died at the advanced age of 79.

ENGINEERING SOCIETIES.

COMING MEETINGS.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 22 to 24. Annual meeting at Chicago, Ill., Secy., W. H. Merrill, Jr., Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
May 28 to June 1. Annual convention at Milwaukee, Wis. Secy., Ralph W. Pope, New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 5. Annual meeting at Atlantic City, N. J. Secy., W. C. L. Eglin, 136 Liberty St., New York, N. Y.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 5 to 7. Annual convention at Cleveland, Ohio. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
June 13. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, 658 Rookery, Chicago, Ill.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 18. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, Old Colony Bldg., Chicago, Ill.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 21-23. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 26. Annual convention at Thousand Islands, N. Y. Secy., Chas. Warren Hunt, 220 West 57th St., New York, N. Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 29 to July 4. Annual meeting at Ithaca, N. Y. Secy., M. S. Ketchum, University of Colorado, Boulder, Colo.

AMERICAN WATER-WORKS ASSOCIATION.
July 10 to 14, inclusive. Annual meeting at Boston, Mass. Secy., J. M. Diven, 14 George St., Charleston, S. C.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 19 to 20. Semi-annual meeting at Chicago, Ill. Secy., W. M. Mackay, P. O. Box 1818, New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
July 23 to Aug. 4. Joint meeting with the Iron and Steel Institute at London. Secy., R. W. Raymond, New York City.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.—The next quarterly meeting of the association will be held at Atlantic City, June 11 to 13, at which time the following papers will be presented: "Economics of Concrete Construction," Mr. E. P. Goodrich; "Etruscan and Roman Mortars as Compared with Modern Concretes," Mr. R. W. Lesley; "Construction of Concrete-Steel Chimneys," Mr. Carl Weber; "Memorandum of the Report of the German Cement Manufacturers' Association," S. B. Newberry.

WASHINGTON SOCIETY OF ENGINEERS.—A special meeting was held at Hubbard Memorial Hall May 1. Mr. C. B. Hunt gave a brief history of the Washington union station agitation and legislation, and said the movement first started in 1896 with the idea of eliminating grade crossings. Mr. Chas. Fernald followed with a description of the new terminal. The station has a frontage on Massachusetts Ave. of about 760 ft. and from the front of the building to the concourse is 330 ft., making the building cover about five acres. It is expected that the building will be completed and ready for occupancy early next year. The total cost of the entire work, including terminal, doing away with grade crossings, etc., will be about $20,000,000 to the railroads and $5,000,000 to the District of Columbia.

LAKE SUPERIOR BRANCH ENGINEERING ASSOCIATION.—This association was organized at Fort William, Ontario, Canada, May 4. The membership includes those persons directly engaged upon the location and construction of the Lake Superior Branch of the Grand Trunk Pacific Ry. Mr. Geo. A. Knowlton, Division Engineer, was appointed Honorary Chairman, Mr. E. W. Cameron, Secretary, and Mr. H. E. Rounthwaite, Treasurer. Meetings will be held bi-monthly, when papers on engineering subjects will be read and discussed and opportunity given for the social reunion of the engineers, which, it is expected, will be conducive to unity of opinion and purpose.

Mr. A. Woods, Assistant Chief Engineer, addressed the assembly and after the conclusion of business a banquet was served.

CONCRETE ASSOCIATION OF NEW YORK.—A meeting of the association was held at the Hotel Astor, New York City, on May 9, with about 25 members in attendance. A paper on the "Manufacture of Portland Cement" was read by Mr. Albert Moyer. Mr. Moyer described briefly the processes of cement m[illegible] it is conducted in the Lehigh cement d[istrict] sylvania and New Jersey. The chief point paper was that cement manufacture 'wa[s] chemical industry, and was a far more chemically than it was usually considered fact was also mentioned that recent investig[ations] Clifford Richardson had shown that the co[ol]ing of cooling cement clinker by a jet of w[ater] definite technological purpose by temperi[ng] and changing its crystalline character to [im]prove ment of the resulting cement. The pa[per] briefly discussed.

APPALACHIAN ENGINEERING ASSOC[IATION].—The regular quarterly meeting was held at H[untington, W.] Va., May 5. The association was entertained by [the] officers and associates of the United States Coal & [Coke Co.], the meeting being held in the opera house bel[onging to the] plant. The afternoon was spent in inspect[ing the] and mines of the company. At the evening [session] I. C. White, State Geologist, of West Virginia, was elected honorary member and gave an interesting [talk on the] history of the West Virginia State Geologi[cal survey, the] benefits to be derived therefrom, and the necessity of the earnest support of, especially, the scientific and professional fraternity. Prof. W. H. Boughton, head of the Civil Engineering Department of the State University, at Morgantown, W. Va., gave an outline of the work done at that institution, and Mr. G. C. Wilkins gave an informal talk on the subject of "Consulting Engineering." After pointing out the great savings and advantages of planning everything before starting the work, Mr. Wilkins presented some cases in point. Mr. H. L. Handly read a paper on the "Polar Planimeter," which will be published in the bulletins of the association.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The twenty-third annual meeting was held in the library of the New Edison Co., 44 West 27th St., New York City, May 15. The principal business of the evening was the adoption of the annual report of the Board of Directors and the reading of the reports of the Committee of Tellers on results of annual election of officers and the proposed new constitution.

Interest was centered in the election of President, as there had been a strong rivalry between the two candidates, Prof. Samuel Sheldon, Brooklyn, N. Y., and Mr. E. Wilbur Rice, Jr., Schenectady, N. Y. Prof. Sheldon was declared elected, having received 1,257 votes as against 907 votes for Mr. Rice, notwithstanding that Mr. Rice received by far the greater nomination ballot. The results of the vote on the rest of the officers elected is as follows: Vice-Presidents, Mr. A. H. Armstrong, Schenectady, N. Y., 2,057; Mr. H. H. Humphrey, St. Louis, Mo., 2,020; Mr. F. G. Baum, San Francisco, Cal., 1,942. Managers, Mr. Paul M. Lincoln, Pittsburg, Pa., 2,080; Mr. Paul Spencer, Philadelphia, Pa., 2,077; Mr. J. J. Carty, New York City, 2,060; Mr. A. M. Schoen, Atlanta, Ga., 1,903. Treasurer, Mr. George K. Hamilton, New York City, 2,176. Secretary, Mr. Ralph W. Pope, New York City, 2,177.

The proposed new constitution was declared defeated due to the fact that according to the present constitution it required 1,680 affirmative votes to adopt it, while only 1,668 votes were cast, of which 161 were against the proposed change.

ILLUMINATING ENGINEERING SOCIETY.—The May meeting was held in the Edison Auditorium, 44 West 27th St., New York City, May 11.

A paper on "A Method of Street Lighting by Incandescent Lamps," by Western Underwood and V. R. Lansingh, was read. This paper described what had been accomplished at Los Angeles in street lighting by incandescent lamps placed on ornamental poles. The poles were placed 100 ft. apart on each side of the street, the illumination obtained being very uniform. The only objection to this style of lighting is the cost. As each pole required 12 amperes at 110 volts this means that the cost of operation is equal to one arc lamp at 6 amperes every 25 ft. Mr. T. V. Westermaier's paper on "Lighting of Streets by the Incandescent Mantel Burner System" described the development of the incandescent gas lamp and showed that in its present state of efficiency it is becoming an active competitor of electricity for street lighting. Mr. F. W. Willcox read a paper on "High Efficiency Incandescent Lamps for Street Lighting." The paper described the G. E. metalized filament lamp which had been developed to such a high state of efficiency that it is becoming an active competitor of the arc light, especially in small towns, since it gives a more uniform street illumination. This lamp operates on three to five amperes with a line voltage of 3,500 to 5,500 volts, the lamps being 25 or 20 candle power. The lamps have been designed for 2.7 watts per candle power, and it was stated that after 1,000 hrs. their efficiency was not less than 75% of that of a new lamp.

The secretary announced that the February, March and April transactions of the society would be mailed to members the coming week.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, May 17, 1906.

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The appeal for aid to assist the engineers of San Francisco who lost heavily in the fire to resume work, made by Mr. Otto Von Geldern, in our issue of May 3, has met with prompt response; and in a telegram dated May 12 we are informed that books and engineering literature are now the principal need. It is also stated that a committee has been appointed, headed by Mr. Edwin Duryea, M. Am. Soc. C. E., to have oversight of the receipt and distribution of contributions for this purpose.

In order to assist those engineers who suffered loss in San Francisco to replenish their working libraries the Engineering News Publishing Co. offers a discount of one-third off the list price of any of its own publications ordered before July 1 through the above committee by any engineer in San Francisco who met with loss in the earthquake and fire. Liberal credit will be extended on all such orders.

An appeal to other technical publishers to join us in this good work has met with prompt and hearty response, and we are pleased to announce that the following publishers will grant the same discount on their publications:

American Architect, 12 West 40th St., New York.
M. C. Clark Publishing Co., 13-21 Park Row, New York.
Engineering Magazine, 140 Nassau St., New York.
The Derry-Collard Co., 109 Liberty St., New York.
G. E. Stechert & Co., 129 West 20th St., New York.
John Jos. McVey, 1229 Arch St., Philadelphia, Pa.

Besides the above list (which includes those received up to the time of going to press) the Hill Publishing Co., of New York City, informs us that it has already offered a discount of 50% on its own publications to engineers suffering loss in the San Francisco fire.

The Morton Memorial Volume, noted in the last part of this Supplement, under Publications Received, is a fitting tribute to the memory of the late Henry Morton, the first and for thirty years President of the Stevens Institute of Technology. At the same time it gives an interesting account of the Institute and of the lives and achievements of the men who have been connected with it as trustees, instructors and students. A notable feature of the volume is its sketch of the engineering achievements of John, Robert L. and Edwin A. Stevens, the first two being the father and brother, respectively, of the founder of the Institute. The Stevens family, as is well known, had a large part in the development of steam transportation by both land and water. A large amount of work preparatory to the publication of this volume was done by President Morton before his death.

Its original scope has been extended and the volume has been ably edited by Prof. F. De R. Furman. President Humphreys has provided it with an introduction. The large number of illustrations, many from paintings and drawings specially prepared for the book, add greatly to the interest of the volume. The preparation and publication of the book has been concluded by others, as it was begun by Mr. Morton, as a labor of love. Considerably less than a hundred copies of the Memorial are available, after supplying the alumni, and these are now offered to friends of the Institute at a price which, considering the heavy cost of the book, is certainly reasonable. College and other libraries and many engineers, we should suppose, will welcome the opportunity now afforded them.

The Key West Extension of the Florida East Coast Railway will be described in a special edition of the Miami "News," about June 1. We are requested to state that a copy of the paper will be sent on application to any engineer who will send his name and address to the "News," at Miami, Fla. The Extension will be about 150 miles long, and will include 30 miles of fill in water and 6 miles of reinforced concrete arch viaducts, of 50-ft. span, and with 25 to 250-ft. drawn-spans. Two 800 × 150-ft. reinforced concrete docks will be built at Key West.

Valves and Valve Gears.

Reviewed by Lionel S. Marks.*

VALVES AND VALVE GEAR MECHANISMS.—By W. E. **Dalby, M. A., M. Inst. C. E., University Professor of Civil and Mechanical Engineering, City and Guilds of London Institute Central Technical College. London, Eng.: Edward Arnold. New York: Longmans, Green & Co. Cloth; 6¼ × 10 ins.; pp. 368; 202 figures, mostly in the text. $6, net.**

VALVE GEARS FOR STEAM ENGINES.—By Cecil H. Peabody, Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology. Second Edition, revised. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 142; 33 folding plates. $2.50.

It is a pleasure to welcome from the new incumbent of the chair which was so worthily occupied by Professor Unwin so satisfactory a book as Dalby's Valves and Valve Gear Mechanisms. In looking at a new work on valve gears it is always a matter of curiosity to see which of the many graphical constructions for determining the simultaneous valve and piston displacements (the so-called valve diagrams) has been adopted by the author and to determine the reasons for his preference. The classic Zeuner diagram is undoubtedly the most largely used, both here and abroad; the Bilgram diagram has many followers in this country; and the extremely simple Reuleaux diagram has its ardent advocates everywhere. For approximate designs, where the angularity of the eccentric rods can be neglected, these three methods permit of the immediate finding of the points of steam distribution without the plotting of any curve, and there is little to choose between them. The elliptical or oval diagram demands much more time to draw, but the result appeals more strongly to the eye; the action of the valve gear is more obvious on inspection. The valve diagram which is used throughout this book is generally known as the Sinusoidal diagram, or, in England, the Osborne Reynolds diagram; it is but little used in this country. In this diagram the displacements from their mid-positions of the valve and piston are plotted horizontally from a vertical center line, which is graduated with a scale of crank positions, so that simultaneous valve and piston displacements are given by the intersection of any horizontal line with the two displacement curves. The drawing in of the two displacement curves is a necessary preliminary to the determination of the points of steam distribution. For designs where the effect of the angularity of the eccentric rods is negligible the method is more cumbersome than the three first mentioned; but it is at least as convenient when very accurate solution is required. It has the advantage that, when desired (as with a link motion or a floating eccentric), a whole family of valve displacement curves may be shown clearly on one sheet.

One feature of this book which is to be commended, and which might well be followed more generally in the text-books, is the separation of the analytical from the graphical treatments of the valve gears. The method followed by the designer of a valve gear and that most convenient for the student to start with is the graphical or geometrical method. The analytical or trigonometrical method is not so much a method for practical use in design as it is the justification of the graphical method or the instrument by which other graphical methods may be devised. The whole subject can be made more attractive to students (especially if the subject of valve gears is part of the first year's work, as is the case in a number of English technical colleges) and the book can be rendered more useful to designers by treating first of the practice of valve gear design and justifying that practice later. The logical mind will, of course, object to this procedure, but the experience of the writer indicates it to be the method giving best practical results.

The scope of the book is limited to the investigation of positive valve gears—trip gears are merely touched upon. Within this field the book is unusually complete, and is admirably arranged. After describing the operations occurring in a steam engine, the various types of steam valves are discussed. Then the construction of piston displacement curves is treated of, and is followed by the simple eccentric gear, the construction of valve diagrams, the determination of the velocity of the valve, general design problems, the design of rocking levers, and the design of steam ports. Independent cut-off gears are also analyzed very fully. Then follows a chapter devoted to the mathematical analysis of the gears treated of up to that point.

The subject of reversing gears, both link motions and radial gears, is handled with great clearness and completeness and illustrated (as, indeed, are most of the gears treated in the book) by the working out of actual gears taken from current practice. The procedure in approaching a new design is described in detail for the guidance of the student. A sufficient space is devoted to the use of templates as an aid in analysis or design. In the design of the Joy gear the author has made use of the general method of graphical analysis which was developed by Mm. Coste and Maniquet in their "Traité Théorique et Pratique des Machines à Vapeur au Point de vue de la Distribution"—a method of great value, but too little known by engineers generally.

The book ends with two chapters to which special attention may be called, as they deal with matters seldom treated in books on valve gears. The chapter on "Statical and Dynamical Problems in Connection with the Design of a Valve Gear" deals with its subject in a very satisfactory manner. The velocity and acceleration diagrams for a Joy gear are drawn according to the graphical method used by Prof. R. H. Smith in his book on "Graphics," the accelerating forces are calculated, and the maximum bending moment on the connecting rod is determined A link motion is treated in a similar way. The problem before the designer after the purely kinematic questions have been settled is here stated and solved with great lucidity. The inclusion of a chapter on this subject is especially to be welcomed, because of the tendency in the instruction of engineering students to segregate courses on kinematics and dynamics in non-communicating water-tight compartments. The final

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chapter deals with the analysis of any valve displacement curve according to Fourier's theorem. The matter of this chapter may not be very pertinent to the general purposes of the book, but it may be recommended to anyone who desires a very clear exposition of the method of determination of the coefficients in Fourier's series.

The second edition of Peabody's Valve Gears for Steam Engines appears fourteen years after the first edition. It is a lineal descendant of Zeuner's epoch-making Treatise on Valve Gears and it is with difficulty that it can be distinguished from its numerous brethren. The first impression that it gives is of absence of originality, of individuality. Such books are useful and are valuable text-books in the hands of an enthusiastic and inspiring teacher, but they lack the spark of life, that indefinable something that makes the difference between the book that stimulates and that which sends its reader into the arms of Morpheus.

Needless to say, the Zeuner diagram is used throughout the book. It is strange that no one has written a text-book in English using and elaborating the Reuleaux (or, as some prefer to call it, the Mueller) diagram. That diagram is of the greatest simplicity and is capable of very complete development. In Ewing's delightful text-book on the Steam Engine, part of one of the chapters is devoted to the application of the Reuleaux diagram to the simple slide valve; it has been the observation of the reviewer that the action and limitations of the plain slide-valve can be grasped by the student more quickly and more comprehensively when the Reuleaux diagram is used in some such manner as that employed by Ewing, than by the use of any other of the existing diagrams. The thing appeals at once to the student; no analytical proof is necessary; it memorizes itself.

The only noteworthy change in the second edition of Peabody's book is the transfer of all analytical demonstrations from the main body of the work to an appendix. This adds materially to the clearness of the book. It is to be regretted that advantage was not taken of the new edition to incorporate some, or indeed most, of the illustrations in the text. It is, of course, a nuisance to have to turn back occasionally to a previous page when the references to a particular figure occur on several pages, but it is a much greater nuisance to have to refer to folding plates at the end of the book for every one of a hundred or more figures. No one of the figures is too large to go on a page; and, besides, folding plates do not last well.

The book deals with its subject in a very business-like manner, giving clear and concise instructions and explanations, and in those respects is a satisfactory introduction to the subject. The first chapter deals with the construction, design, equalization and setting of the plain slide-valve. A very short chapter follows, touching lightly on shifting eccentrics. The treatment of link motions is simple, direct and complete, so far as the elements are concerned; that of radial gears and double valve gears is very sketchy. The final chapter on drop cut-off gears is but little more than a description of four special gears.

CEMENT AND CONCRETE BULLETINS.—Association of American Portland Cement Manufacturers. Read before the Association (as above), March, 1906. Philadelphia, Pa.: The Association. Paper; 6 × 9 ins.

No. 2: The Possibilities of Concrete Construction from the Standpoint of Utility and Art. By William L. Price. Pp. 5.

No. 3: Sand for Mortar and Concrete. By Sanford E. Thompson. Pp. 14.

The first of these pamphlets is a discussion of principles governing the artistic use of concrete in building construction, its author being the architect of the Marlborough Hotel Annex described in Engineering News of March, 1906, and that structure being used as an illustration of the ideas advocated.

The second pamphlet, by Mr. Sanford E. Thompson, is a theoretical and practical discussion of the selection of sand for mortar and concrete. This paper will be the one of most interest to engineers.

The Collection and Disposal of Garbage and Other Municipal Refuse.

THE DISPOSAL OF MUNICIPAL REFUSE.—By H. de B. Parsons, Consulting Engineer, M. Am. Soc. C E., M. Am. Soc. M. E. Author of "Steam Boilers: Their Theory and Design." New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9½ ins.; pp. 186; 73 illustrations, including folding and half-tone plates. $2.

GARBAGE CREMATORIES IN AMERICA.—By William Mayo Venable, M. S., Assoc. M. Am. Soc. C. E., Assoc. M. Am. Inst. E. E., Volunteer Captain Second U. S. Engineers. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9½ ins.; pp. 200; 46 illustrations, including 17 half-tones. $2.

HEAT AND LIGHT FROM MUNICIPAL AND OTHER WASTE.—By Joseph G. Branch, M. Am. Soc. M. E., Chief of the Department of Inspection Boilers and Elevators, Member of the Board of Examining Engineers for the City of St. Louis. St. Louis, Mo.: National Equipment Co. Cloth; 5½ × 8 ins.; pp. 305; 56 illustrations in the text. $3.

After waiting many years for an American book on garbage and refuse disposal we now have published within a few weeks three books on the general subject, each by an engineer. No one of the books covers the whole field, nor do the three together. Mr. Parsons' book serves admirably as a general introduction to the whole subject of the collection and disposal of municipal wastes, but deals briefly and partially with specific disposal plants, and far more adequately with cremation than with reduction. Mr. Venable's book is somewhat broader than his title, in that he discusses collection and also British furnaces, as well as incineration in America. His review of American furnaces is by types, patents and makers, rather than by specific plants. Mr. Branch has practically nothing on collection and very little on reduction. He deals with the utilization of exhaust steam from electric stations as well as with refuse cremation and the utilization of the resultant or accompanying heat. Messrs. Parsons and Brush also treat of heat utilization, and that in a more rational and scientific manner than does Mr. Branch. A large part of Mr. Branch's book is occupied with central heating stations, the elements of electricity, and descriptions of various types of boilers, engines, pumps, gas and oil burners. Mr. Branch exploits a furnace of his own, and also numerous accessories thereto. Mr. Venable is connected with a company that builds furnaces, but although frankly admitting the fact he does not use his book to push his own furnace unduly. Mr. Parsons is the author of a book on steam boilers (reviewed in this Supplement for Feb. 18, 1904) and has designed two furnaces for burning the rejected material from refuse-sorting plants in New York City (see Engineering News, April 17, 1902, and March 2, 1905.)

The foregoing remarks on the three books will convey a general idea as to their contents and the methods and viewpoints of their respective authors. Before taking up each book in detail it may be said that the books as a group deal with disposal by cremation rather than by reduction; that much of what Messrs. Venable and Branch do say of reduction is tinged with bias, perhaps not realized by the authors, but none the less pronounced, and, to the uninformed, misleading; and that in none of the three books is there a clear exposition of the relation of garbage and other refuse to the public health.

After general introductory matter, Mr. Parsons classifies, defines and describes the various city wastes, and presents some tables showing their composition. Most of the statistics have appeared elsewhere, but we do not remember of having seen before a table giving for a number of large American cities, by months, the average daily collections in pounds per capita of garbage, street sweepings, ashes and rubbish, and also totals for the four materials. The following chapter deals in a commendable way with the collection of refuse of all sorts, including separation, carts, central receiving stations, dumping boards, sorting and trimming. A general discussion of all the available methods of disposal is followed by another on reduction and incineration, in the course of which the advantages and disadvantages of each method are discussed and summarized. A chapter on economic considerations reviews such phases of the subject as cost of hauling; revenues from reduction [illegible] cremation; the value of refuse as fuel; [illegible] of "heat-balances," with evaporative results, and with tests of the two New [illegible] practice, furnaces already mentioned as designed by Mr. Parsons. A chapter on Snow Removal [illegible] almost worth the price of the book just for [illegible] words and figures showing the utter impracticability of removal by melting. In New York City [illegible] fire engine to each block of 200 ft. would be required throughout a period of 24 hours to melt the snow-fall assumed by way of illustration. [illegible] final chapter describes briefly furnaces at [illegible] sorting plants in Boston, Buffalo, and New [illegible], and still more briefly a small number of foreign refuse destructors. The design of the [illegible] New York furnaces is shown quite well by [illegible] aid of plans and sections, but the only illustrations of the foreign plants are ground plans. [illegible] minor details are shown by any of the line drawings.

In his introduction the author makes some sensible and forcible remarks on the need of uniform nomenclature and statistics. His own tabular classification of city wastes is in some respects objectionable, but that does no matter much, since little or no use of the unhappy classification is made by him.

The direct benefits of the sanitary disposal of garbage are said to be "augmented indirectly by an increase in the health of the community." This assertion has no basis in recorded vital statistics and less than is popularly supposed in scientific theory. In another place it is said that street sweepings are not suitable for land filling, as they contain putrescible organic matter, which we do not dispute, and disease germs, which if true is of no proved consequence.

In general, Mr. Parsons appears to believe that financial results worth while (not necessarily net profit) can be obtained from burning municipal refuse. He says that there is no reason why the power production from cremation achieved abroad cannot be duplicated in America, and in another place he states that cremation yields returns from heat, clinkers and ashes. He is far more conservative than Mr. Branch and more hopeful than Mr. Venable as to heat utilization, and presents some figures on the subject that will be helpful to others. It must be said, however, that so far as American furnaces yet built are concerned these figures relate to dry rubbish and not to garbage or mixed refuse. As to returns from ashes and clinker produced by American refuse Mr. Parsons gives little if any evidence, at least of general application.

We heartily agree with Mr. Parsons in his opinion that boards of health should have a sanitary supervision of garbage disposal rather than build and operate disposal works; that the whole matter of refuse disposal ought to be handled as an engineering problem; and that the cost of long hauls is a most important factor in studying refuse disposal questions. Finally we take pleasure in commending Mr. Parsons book, within the limits covered by it, as a fair and able presentation of the main points involved in the disposal of municipal refuse, more particularly by cremation.

In considering Mr. Venable's book it must be remembered that its subject is incineration. He deals briefly, however, with quantities of refuse to be handled and with systems of the collection of city wastes. Refuse burning without nuisance, the principles of crematory design and the cost of operating crematories are discussed. A chapter on "Crematory Builders and Their Products" is followed by one on British practice, including steam production, and this by a chapter on materials and methods of construction. Chimneys has a separate chapter.

On the sanitary phases of refuse disposal Mr. Venable is quite unsatisfactory. He makes several unwarranted declarations regarding the necessity of purifying the liquid wastes from garbage reduction plants, saying in one place that this purification must be not sterilization only, whatever that may mean, and in another that when such liquid is discharged into streams it becomes "food for germs of decomposition and injures the water for all purposes." In another

place he asserts that the liquid drained from garbage at a crematory should not be sent to sewage purification works without ascertaining that it "will not be injurious to the works in question." We are at a loss to know what possible injury could be done in this way.

A surprising assertion found in the book is that the "pulp or cake" [meaning tankage] from reduction works

must be disposed of by burning or otherwise. It is often said to be valuable as a fertilizer, but analysis does not bear such statements out.

Surely the author must know, or ought to know, that the tankage from many reduction works is utilized as a fertilizer base.

Mr. Venable gives classified lists of American patents on garbage and refuse furnaces and outlines the history and characteristics of the main types of American furnaces thus far put in use. These features of his book, together with his discussion of materials and methods of construction, will doubtless be welcomed by many.

In a general classification of American furnaces Mr. Venable employs as a basis the amount, or absence, of preliminary drying of the garbage. In one of these classes, which he says is sometimes called the American type, the preliminary drying is the main object; the garbage, in this type, is burned on one grate by subjecting it to heat from an intense fire on another grate. It is interesting to note that as early as 1870 a U. S. patent for a furnace, really suitable for burning dry rubbish, only, was granted to I. O. Smith.

For most American cities Mr. Venable believes that the best plan is to collect ashes separately and use them for filling; and to burn garbage and rubbish in moderate-sized crematories near the center of collection districts. He puts in a form well worth considering the case against what he terms "reburning" ashes, and also the unlikelihood of there being a profitable demand for such steam as can be generated by a refuse furnace. If the mixed system of collection and disposal is really preferable, then, the author says, the British are ahead of us in furnace design; but if not, then we are ahead, since for garbage alone, in his opinion, American furnaces are superior to the British, while for garbage and rubbish (excluding ashes) ours are not generally inferior to the British.

In outlining the contents of Mr. Venable's book we omitted mention of the fact that it closes with a very creditable specification for a garbage crematory, to be unaccompanied by a boiler for the utilization of steam. The main objection to the specifications, it seems to us, is that the various bidders are themselves to supply specifications of the furnaces which they propose to build, which of course means that they also design the furnaces. This may be desirable in some, but certainly not in all, cases. Elsewhere, it is only fair to say, the author points out that any one, who is competent, can design a crematory without infringing on patents, if he understands the existing patents.

As a whole, Mr. Venable's book presents some of the fundamental principles governing, or which should govern, garbage and refuse furnaces, and outlines in a useful manner the various types of American furnaces.

Mr. Branch's book aims to present the possibilities and the methods of obtaining heat and light from city refuse and from the exhaust steam of electric light and power stations. To a large extent it is designed to promote the building of refuse furnaces and central heating stations in general, and Branch furnaces, garbage wagon washers, steam traps and oil burners in particular. Obviously the trade catalogue features of the book detract from its value. Notwithstanding this drawback the book is of value, both because of its information on refuse burning and because of its discussion of central heating stations.

After treating the general subject of wastes, and presenting a comparison of the relative availability of incineration and reduction the author takes up, successively, British, American and his own incinerator, incorporating with the latter his wagon washer and disinfector. The latter, it may be said, consists chiefly of a water heating apparatus. A brief chapter on steam and hot water heating serves as an introduction to a long chapter on "Incinerators Combined with Central Heating Stations," in which is incorporated returns, many very brief, from central heating stations. None of the latter are operated in connection with refuse furnaces, and the chapter contains very little on such combinations. The author argues that refuse burners must be operated day and night, and that as heat is also required day and night during seven months of the year the heat from destructors may profitably be combined with central heating. During the five months of no demand for heat for lighting the heat may be partly

utilized for works purposes and the balance either sold for other purposes, or allowed to go to waste; for there certainly should be sufficient profit made during the heating season alone to satisfy any company.

Such a sanguine and, we must say, superficial view of the subject tends to put the reader on his guard as to other unsupported assertions made by the author.

A chapter of 26 pages on "Elements of Electricity" is entirely out of place in such a volume, being either superfluous or utterly inadequate, according to the amount of knowledge possessed by the reader. The space occupied by this chapter might better have been added to the chapter of seven pages following it, on "Incinerators Combined with Electricity and Water-Works," or to the next chapter, also of seven pages, on "Incinerator Site and Buildings." The subjects treated in the four succeeding chapters are natural and mechanical draft, types of boilers, classes of engines and pumps, gas and oil installations and the comparative value of fuels. The descriptions of boilers, engines and pumps seem, for the most part, quite uncalled for. Most of the illustrations and some of the text are of the trade catalogue order. Remarks on the adaptability of various apparatus for refuse burning and heat supplying plants are of course appropriate to such a book, but these remarks occupy only a small part of the space of the four chapters in which they occur.

The book contains specifications for a central heating plant, contract forms for refuse collection and disposal, and skeleton franchises for gas, electric light and street railway plants, for light, heat and power plants, and for central heating stations. The franchise forms, in particular, are very inadequate for the protection of a city.

A considerable number of errors have been noted: Waste disposal in New York City costs far more than 2 cts. per capita. Chicago, unless we are greatly mistaken, does not "dump all refuse into a drainage canal * * * 1,500 tons daily." San Francisco does not receive a "rebate" of 2% on the 20 cts. per cu. yd. paid for garbage delivered to the privately-owned furnace, for the private scavengers, and not the city, pay for burning the refuse. The city has a percentage of the gross receipts of the company. To say that every large city in Europe, South America, Africa, India and Australia incinerates its refuse is far too sweeping. Paris does not and, unless something very new, neither does Berlin. Probably there are other important exceptions.

Mr. Branch's remarks on reduction contain some of the unqualified and partisan condemnations of the system common to those financially interested in cremation. He says:

Official reports show conclusively that the reduction process has been a failure in every city in this country which has tried same, and especially so in Denver, St. Paul, Buffalo, Chicago, Milwaukee, Detroit, New Bedford, Reading, Pittsburg, Syracuse, Paterson and New Orleans.

In some of these cities there never was a reduction plant, except for experimental purposes, and in at least half of them reduction plants are in operation to-day and are giving at least as good satisfaction as the average American crematory. In another place it is asserted that reduction was tried and failed in England before incineration was adopted. So far as we know reduction was never given a real trial in England. Moreover, incineration in both England and America antedates reduction. As a final instance of the author's partisan statements regarding reduction we quote:

While a properly constructed incinerating plant can never become objectionable, on the contrary, it is impossible to operate a reduction plant without it being a nuisance.

The first part of this sentence is absurd, since the best designed and constructed furnace can be so operated as to produce a nuisance. Many disinterested engineers and sanitarians believe that both crematories and reduction plants, *properly constructed and operated*, can be conducted without a nusiance.

Although we have felt compelled, in justice to possible buyers, to make numerous adverse criticisms of Mr. Branch's book, we wish to say that his position on many points is advanced and commendable. It is desirable that Americans determine whether or not there is heat value in their mixed refuse, and in order that they find out some one must boldly champion the proposition that there is. This Mr. Branch has done, although with more zeal than engineering discretion.

Speaking now, in conclusion, on the three books before us it may be noted that the first two contain about a hundred pages of text, only, while Mr. Branch devotes scarcely if any more space to the refuse disposal itself. A notable feature of the books by Messrs. Parsons and Venable are their wealth of illustrations, including a large number of half-tones. The three books, together, combined with the latest British book on the subject (W. F. Goodrich's "Refuse Disposal and Power Production;" New York, 1904; $5 net) will give the engineer and the student of municipal affairs a very good idea of the present status of the municipal refuse problem, with the exception of disposal by reduction. An earlier

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book by Mr. Goodrich gives more detailed information regarding individual makes of furnaces ("The Economic Disposal of Town's Refuse;" London and New York, 1901; $3.50). Still another British book, published in 1898, but recently revised (how thoroughly we cannot say) is Wm. H. Maxwell's "The Removal and Disposal of Town Refuse" (London; 15 shillings, or $6 in America). Perhaps it should be stated that nearly ten years ago a book entitled "Street-Cleaning and the Disposal of a City's Wastes" was written by the late Col. Geo. E. Waring, Jr. (New York, 1897; $1.25). It contained little on garbage disposal, and devoted considerable space to European street cleaning methods.

RAPID TRANSIT IN NEW YORK CITY AND IN OTHER GREAT CITIES.—Prepared for the Chamber of Commerce of the State of New York by its Special Committee on Recognition of Services of Members of the Chamber on the Rapid Transit Commission. Cloth; 7¾ × 10 ins.; pp. 295; folding plates and other illustrations.

This book gives a concise and non-technical account of the design and construction of the New York rapid transit subway, and incidentally outlines the part played by the New York Chamber of Commerce and by certain of its prominent members in inaugurating and furthering this great enterprise. The volume describes the early plans for rapid transit in New York, the elevated railways and the various river bridges and tunnels up to the formation of the Commission of 1891, with which the present underground railway may be said to have actually begun. The succeeding chapters discuss the work of preparing the contract and describe in a general way the various features of engineering design, construction, equipment and operation of the subway at present in operation. There is also a chapter on future rapid transit in New York, one on the present rapid transit laws and one made up of brief descriptions of the rapid transit systems of other large American and European cities. The volume is illustrated by a number of half-tone views and by several maps.

PERSONAL HYGIENE.—Designed for Undergraduates. By Alfred A. Woodhull, A. M., M. D., LL. D. (Princ.) Brigadier-General U. S. Army, Retired. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 4¾ × 7½ ins.; pp. 221. $1, net.

The author first describes the various parts of the human organism and then tells how to take care of them. Under the second division there are separate chapters on Fatigue, Clothing, Food, Tobacco and Alcohol. As is fitting in a book intended for the young and particularly for college students, stress is laid on moderation in exercise and in the use of narcotics and stimulants during the period of rapid physical and mental development. The author shows a strong leaning towards abstinence from both tobacco and alcohol, but is by no means an extremist in this respect. On the whole, the book is admirable, but perhaps in a volume with such a design as this one some of the space given to details of anatomy and the like might better have been devoted to advice regarding safeguards against communicable diseases spread by impure water, milk and other foods and by the improper isolation of persons suffering from communicable diseases.

TRADES WASTES.—Report to the Water Committee on the Investigation of the Effect on the Water of James River at Richmond. By Ernest C. Levy, M. D., Director of Laboratory of City Water Department. Richmond, Va.: Pub. Doc. Paper; 6 × 9¼ ins.; pp. 28; one map.

So far as we remember, this is the first report published on water pollution by trades wastes in the South. Reference is made, however, to a somewhat similar and earlier investigation made by Professor Howe, of Washington and Lee University for the City of Lynchburg. Dr. Levy concluded that the dark discoloration and foam seen in the James River at Richmond at low water in the fall is due almost if not entirely to waste liquor from the sulphite mill of a pulp and paper company of Covington, Va. The report may be studied with interest in connection with the one by Professor Landreth on the pollution of Lake Champlain, abstracted at length in Engineering News of May 25, 1905, and also in connection with Mr. M. O. Leighton's Water Supply and Irrigation Paper on the pollution of Lake Champlain, published recently by the United States Geological Survey.

PROCEEDINGS OF THE AMERICAN FOREST CONGRESS.—Held at Washington, D. C., Jan. 2 to 6, 1905, under the auspices of the American Forestry Association. Washington, D. C.: The Association (H. M. Suter, Secy., P. O. Box 356). Cloth; 5 × 7¾ ins.; pp. 474.

The sixty-five papers and addresses included in this attractive volume are eloquent testimony to the progress of forestry work in the United States and to the wide and varied interests now associated with the movement. The papers are grouped under seven headings: Forestry as a national industry; importance of public forest lands to irrigation; the lumber, grazing, railroad and mining industries and their relation to the forests and forest lands; and national and state forest policy. First place is very properly given to an address by President Roosevelt, on "The Forest in the Life of a Nation." This address is followed by one by Hon. James Wilson, Secretary of Agriculture, on "The General Need of Forest Preservation," and by another, on "The Forest Policy of France," by Ambassador Jusserand. A number of papers and addresses were presented by members of the U. S. Forest and Reclamation services and by representatives of the industries named above under group headings. Particularly significant among the groups of papers is one on "The Lumber Industry and the Forest," by leading lumbermen and editors of lumber journals. The volume as a whole will be a revelation to those who have not followed the recent development of forestry in the United States, and is a great credit to the American Forestry Association and those who participated in the congress. It deserves careful attention from a wide circle of readers.

THE IMPROVEMENT OF COLUMBIA, SOUTH CAROLINA.—Report to the Civic League, Columbia, S. C., by Kelsey & Guild, Lanscape Architects, Boston, Mass. Columbia, S. C.: Civic Improvement League (address Miss Belle Williams). Paper; 6 × 9 ins.; pp. 88; illustrated. 50 cts.

Commendable spirit has been shown by the Civic League of Columbia in securing such an able and comprehensive report on the improvement of that city. An improved street plan for the city is submitted, and with it a system of parks and parkways within the city and reservations and connecting roads and driveways without the city. The location of the State capitol building at Columbia is made the reason for some of the improvements suggested, including some work to be done by the State. A joint city and State commission is recommended. An important section of the report deals with the street trees of Columbia. It includes a survey of the present condition of the trees, with planting suggestions for each street. It is interesting to note, in connection with the suggestions for parks and parkways, that if these suggestions were carried out the open spaces thus provided would serve to a large extent as fire breaks, dividing the city into some eight or ten fairly well separated districts.

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A Russian Book on Reinforced Concrete.

Reviewed by Leon S. Moisseiff,* Assoc. Mem. Am. Soc. C. E.

CONCRETE STEEL BRIDGES AND VIADUCTS.—(Written in Russian.) By J. Podolsky. Moscow, Russia: The Author. Paper; 7 × 10¼ ins.; pp. 476; 304 figures in the text and many tables. Five roubles.

It is a pleasant surprise to find that in the period of internal stress and regeneration through which the Russian empire is passing at the present time the progress of engineering science continues uninterruptedly. Reinforced concrete had found its way into Russia some twenty years ago, where is was at the beginning chiefly used for floors. Gradually, as its advantages were more recognized and legal obstacles overcome, its use became more general and many railroad structures, culverts and bridges were built of reinforced concrete. Local conditions of materials and labor should in many parts of Russia be very favorable to the extended use of concrete. A complete story of the doings of reinforced concrete in Russia is contained in the report presented by Prof. Serge de Kareliscia to the Seventh International Railway Congress at Washington, in 1905.

The present work on "Reinforced Concrete Bridges and Viaducts" is, to the knowledge of the reviewer, the first and only book in the engineering literature of the world which is especially devoted to bridges and viaducts of reinforced concrete, and it is to be regretted that it has been written in a language so little known outside of Russia. The author treats of his subject in a very clear manner, reminding one of the fine style of some of the best French scientific writings, and at the same time he covers the field comprehensively.

While mention is made of practically all of the most important tests on reinforced concrete and the conclusions arrived at by the experimenters, 24 pages, only, are devoted to the general characteristics of reinforced concrete structures. To the description and illustration of reinforced concrete bridges and viaducts, on the contrary, 182 pages are given. In five chapters covering highway bridges, footwalk bridges, railroad and trolley bridges, aqueducts and bridges of the later designs all kinds of beam and arch bridges are described and illustrated by engineering drawings. All of the more important structures are described and such data on materials, span, dimensions, stresses and acceptance tests as were available are given.

This is followed by 81 pages on the work of construction, which treat of the selection of materials, forms and centers, reinforced concrete columns and piles, piers and ice cutters, the testing of bridges and, finally, some bridge failures. But the main value of the book will be found in the last portion, on the design and computation of reinforced concrete bridges. It covers some 142 pages and contains chapters on the selection of the allowable stresses in the materials used, the methods of computation, the formulas to be used for slabs and beams and, finally, on the computation of the stresses in arches.

After discussing the data supplied by the best known tests on plain and reinforced concrete the author adopts certain allowable working stresses for railroad bridges. These unit stresses are based on the use of a 1:2:4 concrete, and may well be quoted here. They are:

		Lbs. per sq. in.
Concrete in direct compression and flexure		425
Concrete in shear		70
Adhesive resistance of concrete to steel		70
Metal in tension or compression.	wrought iron	10,000
	steel	11,500
Metal in shear.	wrought iron	7,000
	steel	8,500

The ratio of the coefficient of elasticity to that of the metal is taken m = 15.

As is seen from the above table, the unit stresses are 20 to 25% lower than are generally used in the United States, and the author seems to err on the side of safety, which seems to be justified for heavy railroad traffic, at least for the present. For the computation of beams the well known assumptions and formulas adopted by the joint committee of the German engineering and architectural societies are given and as many more deduced as are needed for stirrups, slabs supported on four sides, etc. Numerical examples are given illustrating their various applications.

The computation of the stresses in reinforced concrete arches is especially carefully worked out. The principle of least work, as deduced by Castigliano, is used, and as the moment of inertia and area of the arch vary from point to point, the integrals are replaced by Simpson's formula. The practical application is well illustrated by the complete computation of the stresses in an arch giving each step with the numerical tabulations. The deflection of the arch and its temperature stresses are also computed. For those who prefer graphical computation Mueller-Breslau's simplified graphical method is given, and it is illustrated by two numerical examples.

Finally, the building regulations of several German municipalities, of Paris, New York, the Austrain railroads, some Italian cities and the recommendations of the joint committee of the German engineering and architectural societies are given.

The subject is thus covered very thoroughly and the author deserves credit for his work. The book creates in the reader the wish for a similar work in English, based on American practice mainly.

*Park Row Building, New York.

SHAFT GOVERNORS.—By W. Trinks, M. E., and C. Housum. New York: D. Van Nostrand Co. (Van Nostrand Science Series.) Boards; 3½ × 6 ins.; pp. 97; 27 figures, partly in the text, and 16 tables. 50 cts.

There is a great deal of technical work carried out in the drawing rooms of manufacturing establishments which never finds record in technical literature. A good example of this is the subject covered by this modest little book. The shaft governor has been in extensive use for nearly a quarter of a century; but the student who wished to know how to design or adjust a shaft governor has had to go to other sources than books to find out. Peabody's "Valve-Gears," for instance, first published in 1892, devotes only two pages to the subject of shaft governors.

Any engineering writer who offers sound, practical, useful information on a subject in which no published data have hitherto been available, confers a benefit on the profession; and this applies we believe to the authors of the book before us.

This book is stated to be the outgrowth of notes and rules used by the authors in the design and adjustment of engines. It relates to the *statics* of shaft governing only, and a second volume relating to various dynamic actions in the operation of shaft governors is promised if the present volume meets with a welcome. It is to be regretted that the authors did not see fit to present all this matter in the present volume, increasing it to a more dignified and convenient size, and reducing the number of inserted folding plates. More detailed explanation of the subject would have helped smooth the path of the student; for example, an explanation of just what is meant by the frequently used term "gravity balance." We also note several bad errors in proofreading, which lead to the suggestion that if the mathematical part of the book has not been more carefully corrected than the rest of the text, misleading errors may have crept in there. We hope the book will meet with such a demand that the authors will be encouraged to spend much more work on a revised and enlarged edition.

THIRD ANNUAL REPORT OF THE RECLAMATION SERVICE.—1903-4. (Second Edition.) F. H. Newell, Chief Engineer. Washington, D. C.: Pub. Doc. Cloth; 5¾ × 9¼ ins.; pp. 653; 59 plates (29 in separate case).

Some idea of the magnitude of the work of the U. S. Reclamation Service can be gained by the fact that so large a volume, accompanied by many folding plates, is required to clearly present the operations of the Service during the year and to describe the various projects in hand. Detailed contract bids for various projects are given, and also the results of many stream gagings. Maps, half-tones and line drawings are used as illustrations. One of the large folding maps shows the stream gaging stations of the U. S. Geological Survey throughout the United States, and also, by hatchings, the location and relative areas of the various irrigation projects in the West.

THE GAS WORKS DIRECTORY AND STATISTICS, 1905.—(Revised to July, 1905.) With a List of Chairmen, Managers, Engineers, and Secretaries, and Lists of Associations of Engineers and Managers. London, England: Hazell, Watson & Viney, Ltd. Cloth; 5½ × 8¾ ins.; pp. lxiv + 449. 10½ shillings; American price, $4.20.

This standard work has now reached its twenty-eighth issue. It covers the gas works of England and Wales, Scotland, Ireland and such foreign and colonial works as have their office in London. It gives the population supplied by each works, owner, date built, loans issued and repaid, interest rates, output, prices charged for gas, length of mains, officials and other information. The list of gas associations includes foreign bodies and gives for each organization its date of formation, names and addresses of president and secretary, number of members, date and place of meeting.

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The Steam Engine.

Reviewed by Storm Bull.*

HILFSBUCH FUR DAMPFMASCHINEN-TECHNIKER.—Edited by Josef Hrabák, Professor in the School of Mines at Pribram. Fourth Edition. In three parts. Berlin, Germany: Julius Springer. Cloth; 7¾ × 11 ins.; pp. xix + 220 + 348 + 154; text figures and many tables. 20 marks. American price, $8.

The reviewer has in his possession a copy of the first edition of this work, which was published in 1882. He is also familiar with the later editions and has made considerable use of them, especially in his lectures on the steam engine, during the time which has elapsed since their appearance. If anybody should compare the first with the present edition it would be almost impossible to recognize that it was the same book, at least so far as first appearances are concerned. But, on the other hand, it is also evident that the guiding thought of the author in writing the book has remained the same during all these years. The book was written for the purpose of furnishing to those mechanical engineers especially interested in the steam engine ready means for both computing the principal dimensions of steam engines of any kind and of any power, and also for furnishing the necessary data to closely estimate the steam consumption of the engine to be designed. The author supplies the formulas by means of which these results may be obtained and also their derivation. In addition he gives an enormous number of tables of numerical results from the formulas, worked out for all possible cases occurring in engineering practice. As this is a German book, it needs hardly to be stated that everything is based upon the metrical units, so that the use of the tables is not nearly as helpful to American engineers as to those on the Continent of Europe. However, as there is no book of similar character printed in the English language and based upon our units of measure (there is in fact no other book of this character in the technical literature of the world), it would seem to be necessary for those mechanical engineers of our country who are especially interested in the steam engine to study this book pretty thoroughly. It is not the opinion of the reviewer that everything which the author takes for granted or advocates is the gospel truth; that would be altogether unreasonable to expect or even to hope for; but the reasoning of the author and his conclusions are on the whole very sound. The author has not based his formulas on theory alone; they are rational in character; but by the introduction of proper coefficients, based upon experimental data, the formulas have been made to correspond to engineering practice, so that the tables based upon the various formulas give values which may be directly used in the design of the steam engine. It needs hardly to be pointed out that the author has had especially in view the German engineering practice in this line, which in certain directions is quite different from our own.

The book is divided in three parts, which are bound separately. The first and the second parts contain, respectively, the practical and theoretical divisions of the work. Most of the tables are found in the first part, which may be used entirely independently of the theoretical or second part. One may here find the mean effective pressure for all percentages of clearance found in practice, for all cut-offs from zero to eight-tenths of the stroke, for the various kinds of valve gears, including link motions, and for compound and triple expansion engines. Here will also be found the probable steam consumption for all these different cases, as well as the horsepower of all engines having cylinder dimensions up to the highest limit found in practice, for pressures up to about 200 lbs. per sq. in., and for all the other alternatives mentioned above in connection with the mean effective pressure. The reader may judge from this short enumeration the extent of the tables. A criticism which the reviewer feels he must make is that in some respects these tables have been extended beyond practical limits. For instance, with respect to the pressure where the lower limit is about 45 lbs. absolute for the pressure at admission. There is surely nobody who at the present time designs engines for such a low boiler pressure. Other similar instances might be mentioned where considerable space might have been saved very profitably. But it is evident from the preface to the fourth edition that the author, for various reasons, did not like to cut out anything from the previous editions except it was absolutely necessary.

The third part of the book contains two separate subjects: the engines using superheated steam and the blowing engines. The author some two years ago published a separate book on the engines using superheated steam, which was reviewed in this Supplement for Sept. 15, 1904, and it is this book, considerably enlarged and improved, which forms the first portion of the third part of the work under review. During the two years which have elapsed, considerable practical data bearing upon the use of superheated steam have been gathered. The author has made use of these, so that his deductions and tables can be more relied upon than formerly.

The last portion of part three is called "The Theory and Practical Computation of Blowing Engines." This title sufficiently explains the contents; it is perhaps only necessary to add that a very large number of numerical tables accompanies the text.

*Professor of Steam Engineering, University of Wisconsin, Madison, Wis.

SMOLEY'S TABLES.—Parallel Tables of Logarithms and Squares, Angles and Logarithmic Functions, Corresponding to Given Bevels, and Other Tables. For Engineers, Architects, etc. By Constantine Smoley, C. E. Third Edition. New York: The Engineering News Publishing Co. Leather; 4¾ × 7 ins.; pp. 332. $3 net.

These handy tables have been extended from 50 to 100 ft., and tables of angles and logarithmic functions added, so that engineers and others who found the previous editions of this work a great convenience in making computations will find this edition a greater time saver. The tables from 50 to 100 ft. advance by a 1-16-in. instead of 1-32-in., as do the tables up to 50 ft. The tables of angles and logarithmic functions give the amount of the logarithmic functions of the angle whose natural tangent is the slope given to 12 ins. These tables give slopes up to 12 ins., advancing by 1-32 in. It is apparent that much time can be saved by using these tables in figuring structural steel details, etc.

TRANSVAAL MINES DEPARTMENT.—Annual Report of the Government Mining Engineer for the year ending June 30, 1905. (U. P. Swinburne, Acting Mining Engineer.) Pretoria, Transvaal: Pub. Doc. Paper; 8½ × 13 ins.; folding and other plates and many tables.

Quite detailed reports, accompanied by many tables, are given under the heads: Labor and Wages, Mineral Output, Accidents and Prosecutions, Machinery, Explosives and Stores, Technical Examinations, and General. The chief output, it hardly need be said, is gold.

ATLAS TO ACCOMPANY MONOGRAPH XXXII. ON THE GEOLOGY OF THE YELLOWSTONE NATIONAL PARK.—Arnold Hague. U. S. Geological Survey, Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Cloth; 18½ × 22 ins.; 27 sheets. Paper, $2.80; cloth, $3.75; sheepskin, $4.25.

The monograph which this atlas is designed to accompany, was first published in 1899 ($2.45), the author being Dr. Arnold Hague. Both topographic and geologic maps are included in the atlas.

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Commutator Motors.

Reviewed by Henry H. Norris.*

SINGLE-PHASE COMMUTATOR MOTORS.—By Franklin Punga. Translated from the German by R. F. Looser, M. I. E. E. London, England: Whittaker & Co. New York: The Macmillan Co. Cloth; 4¾ × 7½ ins.; pp. 187; 81 illustrations in the text. $1.75.

The theory and practice of commutation involve several of the most difficult of electrical problems. While the matter has had the careful attention of designers of electrical machinery for a long time, comparatively few of the results of investigations have found their way into the literature of electrical engineering, particularly in this country. It is safe to say that, to a large proportion of the engineers interested in electrical work, the subject is one for the application of judgment rather than calculation. While this is true to a large extent, it does not follow that a knowledge of the theory will not assist in determining the proper proportions and windings of motors and generators to prevent or minimize sparking. The subject of commutation is increasing in importance at the present time on account of the introduction of the single-phase railway motor which will in the near future displace the continuous current motor to a large extent unless in the meantime a still better motor appears. At the present time the large electric railway systems require expensive substations with transformers and rotary converters to transform the alternating current transmitted from the power station at high pressure to the low pressure continuous current needed for the car motors. The use of the alternating current motor does away with all moving machinery in the substations and thus reduces the first cost and maintenance charges. In time the substations may be dispensed with almost entirely, the high pressure current being taken into the cars and there transformed to a pressure suitable for the motors. These single-phase motors are provided with commutators and in them the process of reversal of the current presents even more difficulty than in the older continuous current types.

In a compact and clearly written book, Mr. Punga has placed before us the principles underlying successful commutation in both continuous and alternating current motors. He first analyses the phenomenon of sparking, showing its causes, and how these may be controlled to produce the best results. The direct cause of sparking he states to be the "unequal distribution of current under the brushes." This distribution is carefully studied and the means used for the prevention of sparking in the several types of motor are described and illustrated. As the alternating current motor problem is largely one of successful commutation, the introductory matter is extremely well chosen.

In the main body of the book the author discusses the theory of operation of three types of single-phase motor; namely, the series compensated type, the repulsion type and the compensated repulsion type. In order to follow the discussion of these motors the reader must be familiar with the form and construction of the actual machines, for no descriptions are included. Vector diagrams and diagrams of connections are given, however, so that the text may be readily understood by any one possessing a reasonable acquaintance with ordinary commercial motors. The more difficult proofs are placed in the appendix and are not necessary to the general treatment, which is given in simple language and without elaborate mathematics. A most commendable feature is the introduction of actual designs in which the calculations are worked out with numerical results, so that the reader can check his knowledge by a study of these data.

As a whole the book may be said to be a distinct contribution to electrical literature in that it places within the reach of a large class of readers a concise treatment of a most important topic. As an advanced text-book it is excellent and it is not too heavy for general reading. It may be profitably studied in conjunction with the works of Behrend and de la Tour on induction motors. Such a study will show clearly the distinction between the two general classes of motor, one of which produces a variable and the other a constant speed.

*Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

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D. VAN NOSTRAND COMPANY,
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23 Murray and 27 Warren Streets, - - - NEW YORK.

JAHRBUCH DER SCHIFFBAUTECHNISCHEN GESELLSCHAFT.—Seventh Volume. Berlin, Germany: Julius Springer. Cloth; 7½ × 10¾ ins.; pp. 715; illustrated. 40 marks; American price, $16.

This seventh volume of the proceedings of the German Society of Naval Architects and Marine Engineers covers the spring and autumn meetings of 1906. It contains a number of original papers covering a wide range of subjects of interest to the members, and there are vigorous discussions of several of the papers. The Emperor of Germany is the patron of the society and its flourishing condition is evident from the large membership, now over eleven hundred.

ELECTRIC RAILWAY ACCOUNTING.—The Monthly Report, The Accounting Department, and the Accountant. By W. B. Brockway, General Auditor Nashville (Tenn.) Railway & Light Co. New York: McGraw Publishing Co. Cloth; 5½ × 8 ins.; pp. 84; diagrams. $1.25, net.

The differences between an accountant and a bookkeeper are not as well known as they should be. This little book might be used to illustrate some of those differences. The author approaches his subject by discussing what a report should be: that is, what information an accountant should be expected to give. He next submits a form of report, discusses units of comparison, the use of curves and of statistics, the standardization of accounts and other features of accounting. As a whole, the book is suggestive and instructive.

REPORT ON TESTS WITH AN EXPERIMENTAL PLANT OF THE JEWELL EXPORT FILTER COMPANY.—By Dr. Med. Karl Schreiber, Scientific Member of the Royal Institution of Prussia for the Investigation of Water Supply and Drainage. Translated by E. A. Gieseler, C. E. (Reprinted and translated from "Mitteilungen d. Kgl. Prüfungs-Anstalt für Wasserversorgung und Abwässer Beseitigung," Berlin, 1906. (York, England: The Jewell Export Filter Co., 8, Lendal.) Paper; 7 × 9¼ ins.; pp. 57; three text figures and seven tables.

Detailed results of tests of a small filter (4 ft. in diameter) carried on during a few months in 1905 are here presented and discussed. Most of the numerous tables give the results of bacterial tests. The filter was supplied from the municipal water-works plant in Berlin. Altogether, the report states, the results of the tests were satisfactory.

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THE COST OF COMPETITION.—An effort at the Understanding of Familiar Facts. By Sidney A. Reeve. New York: McClure, Phillips & Co. Cloth; 5 × 7¾ ins.; pp. xix. + 617; 5 plates and 24 diagrams in the text. $2, net.

The author, whom many of our readers know as a professor at the Worcester Polytechnic Institute, approaches his subject as an engineer, an economist and a humanitarian. As an engineer and economist he regrets that economic science is far behind engineering and other sciences, he makes free use of formulas and diagrams, deals extensively with cost data, and deplores the wastes of competition. As a humanitarian he is oppressed with the evils, as he believes, of competition and profit-seeking, and aims to make these clear, both by an elaborate formulation of economic principles, in Part I., "Economic Cost," and by a more general and readable discussion of "The Ethical Cost" [of Competition], in Part II.

In the first half of the book, value, production and consumption, specialization and coordination, exchange, barter, emulation and competition and distribution are treated. In the last half, on the ethics of the subject, the cost of competition to the losers, to the winners and to the community, are considered, and also capitalism and labor, and "Progress without Poverty."

The main argument, if we follow the author, is that if the producers of all classes received the full measure of the wealth which they create, and if what the author conceives to be the unproductive efforts, or idleness, of (mere) capitalists, and the misdirected efforts of all profit-seekers, including the enormous expenses due to competitive efforts, were abolished, then plenty and content and leisure and opportunity for the development of the higher man would be general, instead of being confined to a very small portion of humanity. Professor Reeve believes, with other recent writers, in the necessity for institutional reforms before the greatest of all reforms, that of human nature, can be achieved. He would abolish competition. Mr. F. C. Howe would abolish private ownership of municipal public service industries and adopt the single tax. Mr. Henry George, Jr., would abolish privilege, and with its abolition he also would bring in the single tax. (See reviews in this Supplement: Howe's "The City," Dec. 14, 1905, and George's "The Menace of Privilege," March 15, 1906.) For our part, as in effect we have previously observed, we fear that the evils due to avarice and ambition, on the one hand, and to laziness, incompetence and thriftlessness on the other, will never be abolished by mere institutional or legal changes. Nevertheless, such books as this one and as the two mentioned above deserve welcome, for they bring into clear relief some of the great problems and evils of the day.

It is to be feared that Professor Reeve will discourage many possible readers by his elaborate analysis of economic forces, his formulas and his diagrams. An elimination of a large part of these features and a more popular presentation of the remaining portions would have enabled him to command far more attention than his book in its present form is likely to receive. But such measures, we imagine, would have been truly heroic, for evidently this volume is the result of years of reflection and of formulation of principles. We wish the book well. We commend it to all who are interested in the grave economic, labor and humanitarian problems of the day, and who are possessed of time and courage sufficient to follow through what for these busy days is a long and somewhat technical discussion.

BROOKLYN ENGINEER'S CLUB.—Proceedings for 1905. Constitution and By-Laws, and Catalogue of Reference Works added to the Library during the year. Brooklyn, N. Y.: The Club (Joseph Strachan, Secy., 197 Montague St.) Cloth; 6 × 9¼ ins.; pp. 216; folding and other plates. $2.

Among the papers in this volume we mention: Floating Dry Dock Construction; Computation of Stresses in Blackwell's Island Bridge; Precise Spirit Leveling; and Recent Methods of Tunneling in Soft Ground.

REPORT OF THE DEPARTMENT OF PUBLIC WORKS FOR THE YEAR ENDED JUNE 30, 1905.—Sidney, New South Wales: Pub. Doc. (J. Davis, M. Inst. C. E., Under Secretary for Public Works.) Paper; 8½ × 13 ins.; pp. 112; folding and other plates; 12 text illustrations and many tables.

Railroads, roads and bridges, water supply, sewerage and docks are among the public works cared for by this Department. Besides brief reviews of the operations of the Department for the year, there are reports on cross-breaking tests of coke-concrete, locally manufactured cement, and also on the Liermur pneumatic sewerage system. The reports on the latter subject, by Messrs. C. W. Darley and E. M. de Burgh, Ms. Inst. C. E., are illustrated by many detail drawings, and appear to be the most comprehensive reports on the subject ever published. They relate almost wholly to the Liermur system of sewage collection as in use at Trouville and Stansted, small towns in France and England, respectively. Mr. Darley's report deals with Trouville, and Mr. de Burgh's with both places and with the general phases of the Liermur system and its advantages and disadvantages as compared with other means of collecting sewage.

CLAYS, LIMESTONES AND CEMENTS.—By G. P. Grimsley, Assistant State Geologist. Volume III., West Virginia Geological Survey. I. C. White, State Geologist. (Morgantown, W. Va.: Pub. Doc.) Cloth; 6 × 9 ins.; pp. 565; 44 plates and 54 text figures.

This report is divided into three parts of 311, 111 and 133 pages, respectively, each part being devoted to a different subject. In Part I. the report treats of the clay deposits of the state, describing their origin, chemical and physical properties and classification, and following with chapters devoted to the technology of pottery, sewer pipe, brick and tile manufacture. There is also a chapter on the manufacture of sand lime brick and several chapters on the clay industry and its statistics. Part II. takes up the limestone deposits and industry of the state, and gives a very full discussion of the technology of lime manufacture and of the uses of limestone and lime. Part III. is devoted to hydraulic cement materials and the manufacture, testing and uses of hydraulic cement. The chapters on cement manufacture are on the whole very well prepared. The report is provided with an index.

STATE BOARD OF HEALTH OF THE STATE OF OHIO.—Annual Report for the Year ending December 31, 1904. Springfield, O.: Pub. Doc. Cloth; 6½ × 9½ ins.; pp. 618.

A number of reports on applications for approval of water supply and sewage disposal plants are included in this volume, and also reports, with analyses, on the existing water supplies of the State. There is also [illegible] some 50 pages, on investigation of [illegible] conditions of the Ohio State Penitent[illegible] improvements at the Penitentiary [illegible] mended.

MAINTENANCE OF WAY AND STRU[illegible] Francis How, C. P. A. Reprinted from [illegible] of Accountancy, March, 1906. (Addres[illegible] 26 Broadway, New York.) Paper; 6 [illegible]

Some practical points regarding [illegible] counting and the fallacy of regarding [illegible] funds expenditures for maintenance [illegible] structures are followed by a tabular [illegible] statement of such expenditures for [illegible] railway systems. The figures are gi[illegible] tail classified form, and also by tota[illegible] cost per mile. The number of ties re[illegible] mile of road are also given.

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"I think this will be of great value to men in designing and drafting offices."—Richard Kuhen, Res. Engineer, American Bridge Co., Pittsburg.

"The book appears to be one of the most convenient handbooks for the structural engineer on the market."—C. H. Winslow, Librarian, C. E. Society of St. Paul.

A review of this book recently published makes the false assertion that the book contains principally tables taken without credit from other books. The publisher of that review has so far ignored the author's letter showing the reviewer's allegations to be groundless.

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Formulas and Principles of Cold Storage Insulation.

Reviewed by J. C. Bertsch,* M. Am. Soc. M. E.

THE TRANSMISSION OF HEAT THROUGH COLD-STORAGE INSULATION.—Formulas, Principles and Data Relating to Insulation of Every Kind. A Manual for Refrigerating Engineers. By Charles P. Paulding, M. E. New York: D. Van Nostrand Co. Cloth; 5¼ × 8 ins.; pp. 41; 10 tables and seven figures in the text. $1, net.

Within the space of 41 pages the author of "Practical Laws and Data on the Condensation of Steam in Covered and Bare Pipes" has applied M. Péclet's "Laws and Experiments on the Transmission of Heat Through Insulating Materials" to cold storage insulation in such a concise and convincing manner that it can only be hoped that his little book may find its way into the hands of all who are interested in one way or another in the ice-making and refrigerating business. Péclet's work, "Traité de la Chaleur," is universally recognized as the foundation for all the works on heat-transmission. But inasmuch as "cold" is only a different term for "heat," the same laws are applicable to both, the heating and cooling of space and substances.

The subject of this book is divided in ten paragraphs, of which the first outlines the general principles upon which heat is absorbed, transmitted and emitted by a body. The next two paragraphs give the laws governing the loss of heat by radiation and air conduct. Péclet's table of the radiating values of a great number of different surfaces, together with the coefficients for different temperatures of the surface and objects, as well as for different heights of walls, are used for the construction of several formulas which are finally boiled down to such a form that they can be easily understood and applied.

The fourth paragraph is devoted to the conduction of heat, and the conductivities of a number of solid, powdered and textile materials are given. Paragraphs 5 to 8 show how the heat transmitted through a homogeneous wall, a compound wall, one with air space, and through floors and ceilings can be determined. Numerical examples show the application of the formula and tables, and with the addition of a few illustrations the entire subject is made perfectly clear. But the author is not satisfied with showing only the method of determining the loss of heat through insulations. He goes one step further and furnishes proof for his assertions and for the correctness of his formula by a comparison of his theory with the actual practice. He gives in the ninth paragraph a description of the experiments conducted by the Nonpareil Cork Co., and compares the results of these experiments with the results obtained by applying his rules. The differences between both results are so tritlingly small that the rules and formulas can be accepted as absolutely reliable for all practical work. The concluding paragraph is devoted to the calculation of the loss of heat, or rather cold, through brine and ammonia pipe coverings, for which also formulas and numerical examples are given. The author deserves credit for the first practical, simple and brief method of determining the value of any kind of insulation. It is strange but still true, that very little attention has heretofore been given to the proper construction of cold storage insulations.

The greater part of those going into the refrigerating business, either for ice-making or cold storage, have been of the belief that a refrigerating machine and a lot of piping is all that are necessary to carry on the business, and that it is just a waste of money to use the best of materials and a certain method for the building of the rooms to be cooled. If, then, the work expected cannot be done or only at too great an expense, all the trouble is charged to the machine, and the builder of the machinery has to suffer in many cases for the poor and faulty insulation. All of this could be overcome easily by a free distribution of this little book among those contemplating the erection of a refrigerating plant, and by making the rules given and values obtained the basis for the protection the purchaser has to furnish if he expects certain results. But besides being used as an educating medium, this book is a very desirable and valuable addition to the library of the refrigerating engineer and of the operator of ice and refrigerating machinery.

*Refrigerating Engineer, Cascade Ave., West End, Atlanta, Ga.

Literary Magazines.

Are the Chicago packing houses a menace to public health? This question is being vigorously agitated just now in the public press; and several vigorous writers are bringing a strong indictment against the management of the great packing houses. The "World's Work" for May has three articles upon this subject. The most important one is by Dr. W. K. Jaques, formerly head of the municipal meat inspection at the Chicago stock yards. It appears from Dr. Jaques article (which is corroborated by the others) that there is now no inspection on meats sold for use in the United States sufficient to prevent the sale of meat from diseased animals; and abundant evidence is offered to show that the meat from such animals is sent out for public consumption—perhaps to produce consumption. It will doubtless be news to nearly every one, that the meats sent out to all parts of the country from the great Chicago packing houses are inspected, not by the United States or the State of Illinois, but by inspectors in the employ of the City of Chicago. It is a remarkable illustration of the fact that good government in our cities is a matter of direct public interest and importance to every one.

In the same magazine, the exploitation of Niagara Falls for power production is described, with the movement now on foot to bring about international action for the preservation of the cataract and the prevention of further diversion of the water. The author of the article is unquestionably correct in his condemnation of the structures in the gorge on the American side as the worst injury that has thus far been done at Niagara.

The "Review of Reviews" this month is notable for an able review of the street railway situation in Chicago and the movement for municipal ownership there. In view of the many current criticisms of Mayor Dunne, based on superficial grounds, the article deserves reading by those who would form an intelligent opinion. A paper on the kindred general topic "Municipal Ownership of Public Utilities" in the "North American Review," contains one sentence that is worth quoting and remembering:

> Besides, there is no inherent reason why the mob of voters should not obtain as good and successful management as the mob of stockholders.

In the same magazine Hon. Henry G. Davis writes on the Pan-American Ry.

WOOD PRESERVERS' ASSOCIATION.—Proceedings of the Second Annual Convention, Chicago, January, 1906. Laramie, Wyo.: Secretary, C. W. Berry. Paper; 5¾ × 8½ ins.; pp. 56.

The papers are short and the discussions, which treat of a great variety of subjects, are not reported in full. The principal topics are: Wood block paving; treating Oregon pine timbers; the preliminary steaming of timber before treatment; the education of timber preserving specialists; a railway timber treating plant; specifications for the analysis of coal-tar creosote.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Proceedings of the Twelfth Annual Convention, held at Montreal, Can., Sept. 5, 6, 7 and 8, 1905. (George W. Tillson, Municipal Building, Brooklyn, N. Y., Secy.) Paper; 5¾ × 8½ ins.; pp. 275; illustrated.

A report of this convention was printed and several of the papers were abstracted or reprinted in Engineering News in September, 1906. The papers take up water-works, sewerage, garbage disposal, paving, assessment for betterments, franchises, parks and other subjects.

STATE BOARD OF PUBLIC ROADS OF THE STATE OF RHODE ISLAND.—Fourth Annual Report, January, 1906. Robert F. Roodman, Lafayette, R. I., Engineer; Arthur H. Blanchard, Assoc. M. Am. Soc. C. E., Assistant Engineer, Providence, R. I. Providence, R. I.: Pub. Doc. Cloth; 5¾ × 9¾ ins.; pp. 36; many half-tone plates.

A review of the work of the year, the act creating the board, and specifications for "stone roads" are given in this report.

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WELLINGTON. The Economic Theory of the Location of Railways
Small 8vo, xx + 980 pages, 313 figures. Cloth, $5.00.

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Publications Received.

AMERICAN STREET RAILWAY ASSOCIATION.—Report of the annual meetings of the Association of the Street Railway Accountants' Association of America and of the American Railway Mechanical and Electrical Association; also, Report of Committee on a Standard System of Electric Railway Accounting Covering the Classification of Construction and Equipment Accounts, and Classification of Operating Expense Accounts, Made to and Approved by the Street Railway Accountants' Association of America, 1899. New York: The American Street & Interurban Railway Association (60 Wall St.). Cloth; 6 × 9½ ins.; pp. 453 + 214 + 295 + 70; illustrated.

BOARD OF HEALTH OF THE STATE OF NEW JERSEY.—Annual Report, 1905, and Annual Report of the Bureau of Vital Statistics. Trenton, N. J.: Pub. Doc. Cloth; 5¾ × 9 ins.; pp. 396.

BOARD OF RAILROAD COMMISSIONERS, COMMONWEALTH OF MASSACHUSETTS. — Thirty-seventh Annual Report, January, 1906. Boston, Mass.: Pub. Doc. (No. 14). Cloth; 5½ × 9 ins.; pp. xxxii. + 315 + 691; two large folding maps and many tables.

BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK.—Annual Report, 1905. Commissioners: George W. Dunn, Joseph M. Dickey, Frank M. Baker, George W. Aldridge, Henry N. Rockwell. In two volumes. Albany, N. Y.: Pub. Doc. Cloth; 5¾ × 9 ins.; pp. lxix. + 743 + 1446; illustrations and tables.

BRAYTON STANDARDS.—A Pocket Companion for the Uniform Design of Reinforced Concrete. By Louis F. Brayton, Consulting Engineer. Minneapolis, Minn.: The Author. Leather; 4 × 6½ ins.; pp. 110; illustrations and tables. $3.

A CHAPTER ON LETTERING.—Samples of Figures, Headings, Initials, Scrolls and Titles. Second Edition. Collinwood, O.: (Browning's Industrial Magazine). Paper; 6 × 9 ins.; pp. 28. 25 cts.

CONCRETE-BLOCK MANUFACTURE.—Processes and Machines. By Harmon Howard Rice. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5½ × 9¼ ins.; pp. 152; 46 figures, mostly in the text. $2.

THE CONDITION OF THE AIR OF THE NEW YORK RAPID TRANSIT SUBWAY.—By George A. Soper, Ph. D., Consulting Sanitary Engineer, New York. Reprint from the Medical Record, April 21, 1906. New York: William Wood & Co. Paper; 4¾ × 7¾ ins.; pp. 24; 7 diagrams in the text.

COURSE OF WHOLESALE PRICES, 1890-1905.—Bulletin of the Bureau of Labor, No. 63. March, 1906. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 596.

DIE EISENKONSTRUKTIONEN DER INGENIEURHOCHBAUTEN.—A Textbook for Use in Technical Schools and in Practice. By Max Foerster, Professor of Structural Engineering at the Dresden Royal Technical College. Supplementary Volume to Textbook of Engineering Sciences. Third edition, revised and enlarged. Leipzig, Germany: Wilhelm Engelmann. Paper; 7½ × 11 ins.; pp. 674; 1,000 figures in the text and 19 folding plates; many tables. 44 marks; American price, $17.60.

ELECTRIC TRANSMISSION OF WATER POWER.—By Alton D. Adams, A. M., M. Am. Inst. E. E. New York: McGraw Publishing Co. Cloth; 6 × 9½ ins.; pp. 335; 105 figures in the text. $3, net.

GEOLOGIC ATLAS OF THE UNITED STATES.—U. S. Geological Survey, Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Stiff paper; 18½ × 22 ins.

No. 131: Needle Mountains Folio. Colorado. Pp. 13; six plates.

No. 132: Muscogee Folio. Indian Territory. Pp. 7; three plates and one text figure.

No. 133: Ebensburg Folio. Pennsylvania. Pp. 9; four plates and ten text figures.

HIGH-TENSION POWER TRANSMISSION. — Second Volume. A Series of Papers and Discussions Presented at the International Electrical Congress in St. Louis, 1904. New York: McGraw Publishing Co. Republished by special arrangement with the International Electrical Congress. Cloth; 6 × 9½ ins.; pp. 315; plates and text illustrations. $2.50, net.

HIGHWAY DEPARTMENT, STATE OF OHIO.—Sam Huston, Commissioner. First Annual Report, Feb. 15, 1905, to Nov. 15, 1905. Columbus, O.: Pub. Doc. Paper; 6½ × 9½ ins.; pp. 26.

ILLUSTRATED TECHNICAL DICTIONARY.—In Six Languages: English, German, French, Russian, Italian, Spanish. Compiled after a novel method, by K. Deinhardt and A. Schlomann, Engineers. Vol. I. Lopl. eng. P. Stülpnagel. The Elements of Machinery, and the Tools Most Frequently Used in Metal and Wood Working. New York: McGraw Publishing Co. Munich-Berlin: R. Oldenbourg. Cloth; 4 × 7¼ ins.; pp. 403; 823 illustrations in the text and numerous formulas. $2, net.

THE INDICATOR HANDBOOK.—A Practical Manual for Engineers. By Charles N. Pickworth, Whitworth Scholar, Editor of 'The Mechanical World," Author of "The Indicator Diagram: Its Analysis and Calculation," "The Slide Rule," "Logarithms for Beginners," e'c. Third Edition. In two parts. Manchester and London, Eng.: Emmott & Co., Ltd. New York: D. Van Nostrand Co. Cloth; 4¼ × 7½ ins. 3s., net, per volume; American price, $1.50 per volume.

Part I. The Indicator: Its Construction and Application. Pp. 130; 81 figures in the text.

Part II. The Indicator Diagram: Its Analysis and Calculation. Pp. 132; 148 figures in the text.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.—Proceedings of the Tenth Annual Convention, held at Erie, Pa., August 23, 24 and 25, 1905. (Frank P. Foster, Secretary, Corning, N. Y.) Cloth; 5¾ × 8¾ ins.; pp. 186; illustrated.

INTERSTATE COMMERCE COMMISSION.—Nineteenth Annual Report, December 14, 1905. Washington, D. C. Pub. Doc. Cloth; 5¾ × 9 ins.; pp. 207.

THE MANUFACTURE OF CONCRETE BLOCKS AND THEIR USE IN BUILDING CONSTRUCTION.—By H. H. Rice, Secretary, American Hydraulic Stone Co., Denver, Colo.; Wm. M. Torrance, M. W. S. E., Assistant Engineer Hudson Companies, New York, and others. New York: The Engineering News Publishing Co. London: Archibald Constable & Co., Ltd. Cloth, 6 × 9 ins.; pp. 122; illustrated. $1.50, net.

MARINE BOILERS.—Their Construction and Working, Dealing More Especially with Tubulous Boilers. Based on the Work by L. E. Bertin, Late Chief Constructor of the French Navy. Translated and Edited by Leslie S. Robertson, Secretary of the Engineering Standards Committee, M. Inst. C. E., M. Inst. M. E., M. Inst. Naval Architects, etc., etc. With a new chapter on "Liquid Fuel," by Engineer-Lieutenant H. C. Anstey, R. N., Assoc. M. Inst. C. E., M. Inst. M. E., and a preface by Sir William White, K. C. B., F. R. S. Second Edition, revised and enlarged. New York: D Van Nostrand Co. Cloth; 5¾ × 9 ins.; pp. xxxvi. + 658; 350 illustrations, mostly in the text. $5, net.

METALLURGICAL CALCULATIONS.—By Joseph W. Richards, A. C., Ph. D., Professor of Metallurgy in Lehigh University, Author of "Aluminium, Its Metallurgy, etc." Part I. Introduction, Chemical and Thermal Principles, Problems in Combustion. New York: McGraw Publishing Co. Cloth; 6 × 9 ins.; pp. 208. $2, net.

MORTON MEMORIAL.—A History of the Stevens Institute of Technology, with Biographies of the Trustees, Faculty and Alumni, and a Record of the Achievements of the Stevens Family of Engineers. Edited by Franklin De Ronde Furman, M. E., Professor of Mechanical Drawing and Designing. With an Introduction by Alexander Crombie Humphreys, M. E., Sc. D., LL. D., President of Stevens Institute of Technology. Hoboken, N. J.: The Institute. Half morocco; 8 × 11½ ins.; pp. 641; numerous illustrations. $10.

NOTES ON ELECTROCHEMISTRY.—By F. G. Wiechmann, Ph. D. New York: McGraw Publishing Co. Cloth; 5½ × 8¼ ins.; pp. 145. $2, net.

A PRACTICAL MANUAL OF TIDES AND WAVES.—By W. H. Wheeler, M. Inst. C. E., Author of "Tidal Rivers," "The Sea-Coast," etc. London, New York and Bombay: Longmans, Green & Co. Cloth; 6 × 9½ ins.; pp. 201; 19 illustrations, mostly in the text. **$2.80, net.**

THE PRINCIPLES AND PRACTICE OF IRON AND STEEL MANUFACTURE.—By Walter Macfarlane, F. I. C., Principal of the Metallurgical Department, Staffordshire Education Committee. London, New York and Bombay: Longmans, Green & Co. Cloth; 5 × 7¾ ins.; pp. 266; 96 illustrations in the text. $1.20, net.

PROFESSIONAL PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11½ ins.

No. 49: Geology and Mineral Resources of Part of the Cumberland Gap Coal Field, Kentucky. By George Hall Ashley and Leonidas Chalmers Glenn, in cooperation with the State Geological Department of Kentucky, C. J. Norwood, Curator. Pp. 239; 40 plates (one in pocket) and 13 text illustrations.

RAILROAD AND WAREHOUSE COMMISSION OF THE STATE OF ILLINOIS.—Thirty-fifth Annual Report. Railroads for the Year Ending June 30, 1905. Grain Inspection Department for the Year Ending Oct. 31, 1905. Office Expenses for the Year Ending Nov. 30, 1905. James S. Neville, Bloomington, Chairman Commission: Wm. Kilpatrick, Chicago, Secretary. Springfield, Ill.: Pub. Doc. Leather; 5¾ × 8¼ ins.; pp. 509; folding and half-tone plates and many tables.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.—Proceedings of the Twenty-third Annual Convention, Niagara Falls, N. Y., Sept. 12, 13 and 14, 1905. (C. E. Jones, Secretary, Beardstown, Ill.) Paper; 5¾ × 8½ ins.; pp. 147.

THE SEVEN FOLLIES OF SCIENCE.—A Popular Account of the Most Famous Scientific Impossibilities and the Attempts Which Have Been Made to Solve Them. To Which Is Added a Small Budget of Interesting Paradoxes, Illusions and Marvels. By John Phin, Author of "How to Use the Microscope," "The Workshop Companion," "Century of Inventions," etc. New York: D. Van Nostrand Co. Cloth; 5¼ × 7¾ ins.; pp. 178; 34 figures in the text. $1.25, net.

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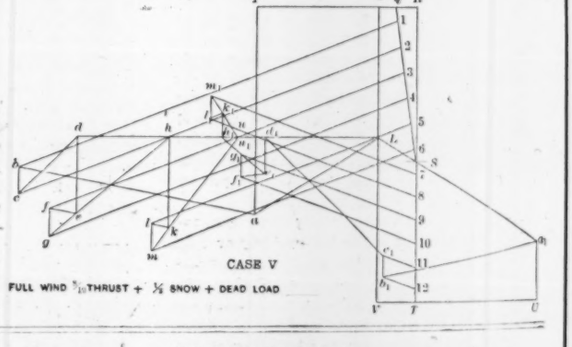

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